BOSTON UNIVERSITY

SCHOOL OF EDUCATION

Dissertation

SOME EFFECTS OF THE COMPULSORY USE OF METRIC WEIGHTS AND MEASURES

A Study of the Results of the Compulsory Use of Metric Weights and Measures in Brazil, Argentina, Uruguay, and Paraguay

Submitted by

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Acknowledgments

Perhaps the happiest moment in the many hours, which have been spent in preparing this dissertation, is this one when the investigator at last has the opportunity of expressing in tangible form most sincere thanks to the many friends and acquaintances both at home and abroad who have given so generously of their time and effort in supplying information and in contributing constructive criticism.

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Beyond the walls of Boston University countless friends and acquaintances have helped to make this work possible. Among these thanks is due

especially to Dr. Walter R. Ingalls, President of the American Institute of Weights and Measures, and to Señor Ildefonso Falcão, the Brazilian Consul in Boston.

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(Administración Nacional de Combustibles, Alcohol, y Portland Cement), Montevideo; and Mr. Ernest Shepherd, a business man in Buenos Aires, whose charming wife took this North American stranger into their home, and who himself spoke the magic "Open Sesame" before so many doors in the Argentine.

CONTENTS

LIST OF TABLES

LIST OF APPENDICES[1]

[1]See Vol. II of this dissertation.

Page

Page

CHAPTER I

THE PROBLEM

The Importance of the Problem

That the question of weights and measures is of importance in the field of education in the United States today is evidenced by the interest of teachers and the academic group, in general,[1] in the agitation for changing the permissive use of metric weights and measures, which dates back to July 28, 1866, to their compulsory use, enforced by penalties. This group, together with some others, have presented petitions to Congress.[2] Frequently, also, there has been agitation in this direction by Parent-Teacher Associations,[3] Women's Clubs,[4] Rotary Clubs,[5] Kiwanis Clubs,[6] and so forth. As recently as 1929, Osburn, a well-known educator, stated that the use of metric units is the remedy for the difficulties which children have

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1/Hearings before House Committee on Coinage, Weights, and Measures on Metric Bill, H.R. 10, United States Sixty-ninth Congress, First Session, Washington: Government Printing Office, 1926, pp. 7, 26, 320, 331-332. See also Weights and Measures in the United States, Arguments for and against a Change, Special Report No. 34, New York: National Industrial Conference Board, Inc., 1926, pp. 10, 19.

2/Hearings before a Subcommittee of the Senate Committee on Manufactures, on S.2267, United States Sixty-seventh Congress, First and Second Sessions, Washington: Government Printing Office, 1922, pp. 331, 368.

3/Ibid., p. 37.

4/United States Hearings, 1926, op. cit., pp. 52, 331.

5/United States Hearings, 1922, op. cit., pp. 364, 370. See also United States Hearings, 1926, op. cit., p. 332.

6/Ibid., p. 367. See also United States Hearings, 1926, op. cit., p. 331.

with denominate numbers.[1]

The Statement of the Problem

The purpose of this research is to discover what has happened in countries which have made the use of metric weights and measures compulsory by law, imposing penalties for the use of customary weights and measures.

Three main questions have been studied in this investigation. They are:

1. What customary weights and measures are used in trade and industry in the countries studied in continental Europe and in South America where the use of metric units is compulsory?

2. To what extent, in general, are customary weights and measures used in these countries?

3. What further effects does the compulsory use of metric weights and measures have in these countries?

Inevitably certain other highly controversial questions arise in a study of this nature. The investigator has studied the most important of these carefully and has formulated opinions in regard to them but no attempt is made in this dissertation to present authoritative answers. The following questions,[2] however, will be discussed:

4. Why do customary weights and measures continue to be used in the countries investigated in disregard of the laws and in spite of severe penalties?

5. Does the metric substitute plan operate as a system with most of the well-advertised benefits such as economy in calculations and ease of learning?

6. What modifications or adaptations of metric units occur?

1/Worth J. Osburn, Corrective Arithmetic, Boston: Houghton Mifflin Company, 1929, Vol. II, p. 75.

2/See Appendix C, pp. 213-235 for a discussion of the advantages and disadvantages of metric weights and measures.

Metric is herein defined as the forty-five[1] (not including the franc) weights and measures of the original metric system (1792) and logical extensions of the same. Customary is defined as the weights and measures which through the centuries have survived on the basis of usage rather than fiat. A metricised unit is defined as a customary unit expressed in metric values. Trade includes retail and wholesale; domestic and foreign.

The countries studied in South America were: Brazil, Argentina, Uruguay, and Paraguay. A review was made of Halsey's study[2] in South America and of Kennelly's study[3] in Europe. The latter covered France, Switzerland, Germany, Belgium, Holland, Spain (including Majorca), Italy (including Sicily and Sardinia), Austria, Czechoslovakia, Denmark, Sweden, Norway, and Rumania.

The metric system, as set up in 1792 by the Academy of Science, was promulgated, and since has been defended as though it were a vast improvement over any previously developed system.[4] The brief history of weights

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1/

Units	Multiples	Sous-Multiples
mètre	myria	déci
are	kilo	centi
stère	hecto	milli
litre	déca	dimilli
gramme		
(franc)		

As may be seen from the above for each of the five units there are eight possible combinations. For example: mètre, myriamètre, kilomètre, hectomètre, décamètre, décimètre, centimètre, millimètre, and dimillimètre.

2/Frederick A. Halsey, The Metric Fallacy, New York: The American Institute of Weights and Measures, 1919.

3/Arthur E. Kennelly, Vestiges of Pre-Metric Weights and Measures Persisting in Metric-System Europe 1926-1927, New York: The Macmillan Company, 1928.

4/Guillaume Bigourdan, Le Système Métrique des Poids et Mesures, Paris: Gauthier-Villars, 1901, pp. 60-65, 71, 160-171, 178-180, 211-214, 239-240, 248-274. See also United States Hearings, 1922, op. cit., pp. 4-82, 117-169, 321-439; Le Système Métrique Décimal, Paris: Gauthier-Villars et Compagnie, 1930, pp. 50, 53-55, 69, 238, 247; and Commissioner's Second Report on Exchequer Standards, London: Eyre and Spottiswoode, 1869, pp. 116-117, 119.

and measures in Chapter II shows that, while weights and measures always are in a state of change, those which have become especially adapted, whether they are customary or metric, do tend to survive through the centuries.

A Summary of the Conclusions

A reader frequently is helped by seeing the conclusions at the beginning of a study. Summarized, the conclusions arrived at as a result of this investigation are:

1. The customary weights and measures used in trade and industry in the countries studied in continental Europe and South America, where the use of metric units is compulsory, are those which are most convenient, and so have become a part of the people's thinking such as: the inch, the pound, and the foot. Next to these three in frequency of use in South America are the arroba (25.35 pounds)[1/] and the palmo (8.66 inches).
2. The extent, in general, to which customary weights and measures are used in the countries studied is indicated by the results of the following investigations:

Table 1. A Comparison of the Data of Three Different Investigators in South America and Continental Europe, Showing the Extent of Customary and Metric Usage in Countries where the Use of Metric Weights and Measures Is Compulsory.

Investigator	Place	Per Cent of Customary	Per Cent of Metric
Halsey	South America	44%	56%
Yorke	South America	35%	65%
Kennelly	Continental Europe	28%	72%

That is, three different investigators found in South America and in continental Europe customary weights and measures totaling

1/Spanish.

approximately 44%, 35%, and 28%, respectively, as per the above table. Obviously, this is not inconsequential because the use of metric units is compulsory in all of the countries studied.

3. The compulsory use of metric weights and measures has had the following effects in the countries studied:

   a. It has created a mixed system. The metric units never have been used exclusively, even in France, where the customary tonneau de jauge or gage-ton (100 cubic feet) has been officially adopted,[1/] together with customary units of time, angles, and navigation, as well as many modified units, such as the demi-kilogramme and the double-mètre,[2/] which are permitted, to meet the requirements of the law and yet allow the people to think in customary units.

   b. It has caused confusion in thinking.

   c. It has caused much useless labor in calculating and making conversions.

   d. It has caused disregard and evasion of the laws.

   e. It has caused a great amount of social and private cost to:

      (1) The governments, for inspectors and enforcement;

      (2) Business, industry, trade, and commerce, for calculating conversions, and for machinery equipped with both customary and metric gages and devices.

   f. Due to the mixed system it has made learning in the field of weights and measures more difficult for children in the schools, necessitating the learning of conversions as well as many additional units.

1/Kennelly, op. cit., p. 53.

2/Demi-kilogramme (livre or pound).
Double-mètre (toise or fathom).

CHAPTER II

THE METROLOGICAL BACKGROUND OF THE PROBLEM

The following discussion is not essential to maintain the thesis developed in this dissertation, but it will help a reader who does not already realize that measures and weights grow like customs, and that in the long run the measures and weights, whether customary or metric, which survive, are those that are best adapted to the purposes for which they are used.

Primitive Measures and Weights

The history of measures and weights begins with the needs of primitive man. Barter, one of his earliest activities, required a measure of quantity. Some metrologists believe that count was used first, but that as greater exactness was needed, other units were sought.[1/] The origin of these primitive measures and weights, of course, is unknown. Although there is no evidence supporting such a theory, many authorities hold that primitive man first used, for convenience, parts of his body with which to measure length, such as: the breadth of a nail, of a thumb, of a forefinger, or first joint; the width of a palm, as measured across the middle joints of the fingers; the length of a foot, of a forearm, or of an arm;[2/] the span of the

1/Frederick A. P. Barnard, The Imaginary Metrological System of the Great Pyramid of Gizeh, New York: John Wiley and Sons, 1884, p. 1.

2/Henry J. Chaney, Our Weights and Measures, London: Eyre and Spottiswoode, 1897, p. 23.

Tradition says that the French "pied de Roi" (12.79 inches) was the length of Charlemagne's foot (768-814 A.D.); that the "black cubit" of the Arabs (21.28 inches) used on the plains of Mesopotamia by astronomers in measuring a degree of the earth's surface (830 A.D.), originated from the length of the forearm of one of Caliph Al-Mamun's favorite black slaves; and that the English yard, made legal in 1101 by Henry I, was the length of that monarch's arm. Such hypotheses are interesting, although there is no evidence to uphold them.

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extended thumb and fingers of one hand; the distance which could be reached from the end of the nose; or the distance between the tips of fingers when arms were outstretched.[1] Other authorities think that he used small natural units, such as seeds of grain or of other plants, laid end to end.[2] To measure longer distances some metrologists believe that primitive man used a pace (the ground which could be covered in one step--from the heel of one foot to the heel of the other); the distance a strong man could run without having to stop for breath,[3] and the distance a man was able to travel in one day from sunrise to sunset, or in one night from sunset to sunrise. Such a custom is recorded in India, where the "yojana" was the distance an army could march in one day.[4]

When, however, primitive man began to think beyond his immediate needs, and to accumulate stores of grain, cattle, and slaves to satisfy his wants in the future, and to exchange for other commodities he needed, weights became a necessity. The theory that he first used seeds is supported by the discovery in prehistoric Egyptian graves of the Amratian period (c. 8000 B.C.) of the beq, weighing about 200 grains, from which can be traced the pound.[5] The paramânu of India, a seventh part of a fine grain of dust, so infinitely minute that "it cannot be divided further without arriving at nothingness,"

1/William Hallock and Herbert Wade, Outlines of the Evolution of Weights and Measures and the Metric System, New York: The Macmillan Company, 1906, p. 2.

2/Chaney, op. cit., p. 24.

3/Hallock and Wade, op. cit., p. 25.

4/Buddhist Records of the Western World, Translated from the Chinese of Hiuen Tsiang (A.D. 629), London: Trübner and Company, 1884, Vol. I, p. 70.

5/William Matthew Flinders Petrie, Measures and Weights, London: Methuen and Company, 1934, p. 26. See also William Matthew Flinders Petrie, "Measures and Weights," Encyclopaedia Britannica, 14th ed., Vol. XV, p. 145.

as the Chinese scholar and pilgrim, Hiuen Tsiang, described it in "Si-Yu-Ki" (629 A.D.)[1/] has led some authorities to believe that later other natural weights were used.[2/]

That the units of capacity developed in general later than those of weight has been advanced as a theory because capacity measures even today are unknown in some primitive Asiatic tribes.[3/] Natural objects, such as egg shells or gourds are believed by some metrologists to be the first measures of this kind. As the need increased, primitive balances were invented. Illustrations of these may be seen in the Egyptian tombs of the V (c. 2700 B.C.), XI (c. 2200 B.C.), XII (c. 2100 B.C.), and XVIII (c. 1500 B.C.) dynasties. The early Egyptian records indicate that only gold, silver, copper, and precious stones were weighed with balances until the XVII dynasty (c. 1700 B.C.). Gradually, however, their use increased until, during the time of the Ptolemies (329-30 B.C.) incense, honey, and drugs were also weighed by this means.[4/]

When primitive man began to cultivate the land, he needed some way of measuring surface, and although there is no evidence to support the theory, some authorities believe that he first used seed-measures, that is, the amount necessary to sow a field;[5/] but that later the area of land was

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1/Buddhist Records, op. cit., p. 70.

2/Petrie, op. cit., p. 19. See also Hallock and Wade, op. cit., p. 29.

3/Hallock and Wade, op. cit., p. 5.

4/Ibid., p. 24. See also Arthur Edward Pearse Brome Weigall, A History of the Pharoahs, London: Thornton Butterworth, 1925, Vol. I, p. 61; and J. Gardner Wilkinson, The Manners and Customs of the Ancient Egyptians, London: John Murray, 1878, Vol. II, p. 224.

5/Edward Nicholson, Men and Measures, London: John Murray, 1912, pp. 65, 90.

measured by the amount of ground that could be worked by a man, or ploughed by a yoke of oxen in a specified time.[1/]

The Evolution of Standards

As civilization developed, measures and weights slowly evolved. When only the convenience of the individual had to be considered, there was no need for any uniformity, but as tribal life grew, standards became necessary, and so it was found desirable to lay off units of measure on some surface, or to make concrete reproductions, which could be consulted readily, and could be preserved. Thus a single system might be devised for a household, a family, a small group, a tribe, or a nation.[2/]

In the Louvre at Paris may be seen the oldest scale of linear measures in existence. It consists of a double line, crossed by a number of indentations, which is engraved near the outer edge of a stone slab, held on his knees by the decapitated Babylonian King, Gudea, as he prays. From this scale, using the ratios found on the Senkereh Tablet of clay (c. 2500 B.C.), which has the fractions and multiples of the cubit on one side, and the squares and cubes of the cubit from 1 to 60 on the other, it is possible to calculate the lengths of the various Babylonian units.[3/] Another such standard of Egypt, the ater, a long-distance measure, has been discovered on the Memphis-Faium road,[4/] while the dimensions of the royal building

1/Old Testament, First Kings, 14: 14. See also Nicholson, op. cit., p. 7; and Kennelly, op. cit., pp. 32, 44, 85.

2/Hallock and Wade, op. cit., p. 2.

3/Hastings' Dictionary of the Bible, New York: Charles Scribner's Sons, 1900, Vol. I, p. 218. See also Carl Richard Lepsius, Die Babylonisch-Assyrischen Längenmasse nach der Tafel von Senkereh, Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin, 1878, p. 105 et seq.; and Ernest de Sarzec, Découvertes en Chaldée, Paris: E. Leroux, 1884-1900, Première Partie, p. 136 et seq., pl. 14-20.

4/William Matthew Flinders Petrie, "Weights and Measures," Encyclopaedia Britannica, 9th ed., Vol. XXIV, p. 483.

cubit have been preserved on stone scales and on the wooden one of Amenoemopht, which was found in the necropolis at Memphis.1/ Likewise divisions cut on a wall at Abydos record the Trojan cubit.2/

Standard weights were made of stone and metal from units consisting of a certain number of seeds3/ or other natural objects, some authorities believe. The earliest prehistoric (c. 8000 B.C.) weights, which have been found, are Egyptian--short, cylindrical forms with domed ends. Somewhat later the Egyptians used conical and rectangular4/ forms. Early Persian ones were made in the form of cowry shells;5/ the Syrians used barrel and sheep forms;6/ while the Babylonians (c. 2700 B.C.) made them in the forms of a duck, sitting with its head turned and flattened on its back, and of a crouching lion.7/ By 1500 B.C. during the XVIII dynasty in Egypt weights were made in the form of animals or animal heads such as: cows, bulls, calves, oxen,8/ ibexes, lions,

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1/Lepsius, Die Altägyptische Elle und ihre Eintheilung, Philologische und Historische, Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin, 1865, Seite 1, p. 14.

A wooden measuring rod used in Egypt during the XX-XXII dynasties (1580-1150 B.C.) and a fragment of a green slate cubit rod, used during the New Kingdom (1580-945 B.C.), both found at the North Pyramid of Lisht, may be seen in the Metropolitan Museum of Art, New York City. See Appendix A, p. 197.

2/Petrie, op. cit., p. 7.

3/Hallock and Wade, op. cit., p. 4.

4/Examples of such Egyptian weights may be seen at the Metropolitan Musuem of Art, New York City. See Appendix A, pp. 187-193.

5/Petrie, op. cit., p. 19. See also "Measures and Weights," Encyclopaedia Britannica, 14th ed., Vol. XV, p. 145.

6/William Ridgeway, The Origin of Metallic Currency and Weight Standards, Cambridge: University Press, 1892, p. 271.

7/H. W. Chisholm, Weighing and Measuring, New York: The Macmillan Company, 1887, p. 41.

8/A 6 deben (approximately 2.97 ounces) bronze weight in the form of a recumbent cow or calf, a bronze weight in the form of a recumbent ox, weighing approximately 2.08 ounces, a 2 kidet (approximately 0.62 ounce) bronze ox's head weight, all used in Egypt during the Empire or Imperial Period (1580-1090 B.C.); and a glass bull's head weight, found at Thebes in the palace of Amenhotep III (c. 1500 B.C.), may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, pp. 194-196, 198.

cubit have been preserved on stone models and on the wooden one of Amenemopet, which was found in the necropolis at Memphis.[1] Likewise divisions cut on a wall at Abydos record the Egyptian cubit.[2]

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A wooden measuring rod used in Egypt during the IX-XVII dynasties (1580-2150 B.C.) and a fragment of a green slate cubit rod, used during the New Kingdom (1580-945 B.C.), both found at the North Pyramid of Lisht, may be seen in the Metropolitan Museum of Art, New York City. See Appendix A, p. 197.

2/Petrie, op. cit., p. 7.

3/Hallock and Wade, op. cit., p. 4.

4/Examples of such Egyptian weights may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, pp. 197-198.

5/Petrie, op. cit., p. 12. See also "Measures and Weights," Encyclopaedia Britannica, 14th ed., Vol. XV, p. 145.

6/William Ridgeway, The Origin of Metallic Currency and Weight Standards, Cambridge: University Press, 1892, p. 271.

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hippopotami, and wolves. Hellenistic and Roman weights of an early period were cast in lead--square, or in the form of octopuses, and ducks. Also bronze lions,[1] or bowls, such as the Cypselid golden bowl were used, but late Roman weights were commonly made of bronze (square or round), or of glass.[2] Great bronze ingots were used early in Italy.[3] The Arabs used large bun-shaped, bell-shaped, disc, and cuboid glass weights.[4]

Units of capacity, likewise, needed to be standardized. Metrologists believe that the first of these were baskets or jars made in sizes convenient for carrying water or grain.[5] Some of the oldest existing illustrations of such measures may be seen in Egypt --thin metal cylinders for liquids and wooden ones for grain,[6] painted full-size on the walls of the tomb of Hesy, III dynasty (c. 2800 B.C.). Measures of this kind were also made of stone and bronze, sometimes in the form of boat vases, or bowls.[7]

1/Petrie, op. cit., p. 19.

2/Petrie, Glass Stamps and Weights, London: University College, 1926, p. 2.

An Egyptian fused glass ring weight of the Roman Period (30 B.C.-639 A.D.) may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, p. 198.

3/Petrie, Measures and Weights, p. 16.

A bronze ingot weighing 61.96 pounds, said to be from Asia Minor, may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, p. 199.

4/Petrie, Glass Stamps and Weights, p. 4 et seq.

An olive green translucent glass weight, used in Egypt during the Arabic Period (996-1020 A.D.), may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, p. 198.

5/Hallock and Wade, op. cit., p. 5.

6/Cecil M. Firth, and J. E. Quibell, Excavations at Saqqara, The Step Pyramid, Le Caire: Services des Antiquities de l'Egypte, 1936, Vol. II, Pt. 13, 17.

7/Petrie, Measures and Weights, p. 17.

See Appendix A, pp. 200-204 for additional photographs of Egyptian weighing machines, a water-clock, and a Nilometer, which may be seen at the Metropolitan Museum of Art, New York City.

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1/Petrie, *op. cit.*, p. 10.

2/Petrie, *Glass Stamps and Weights*, London: University College, 1926, p. 2.

An Egyptian fused glass ring weight of the Roman Period (30 B.C.-300 A.D.) may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, p. 186.

3/Petrie, *Measures and Weights*, p. 22.

A bronze ingot weighing 61.56 pounds, said to be from Asia Minor, may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, p. 190.

4/Petrie, *Glass Stamps and Weights*, p. 4 et seq.

An olive green translucent glass weight, used in Egypt during the Arabic Period (950-1050 A.D.), may be seen at the Metropolitan Museum of Art, New York City. See Appendix A, p. 185.

5/Hallock and Wade, *op. cit.*, p. 5.

6/Cecil M. Firth, and J. E. Quibell, *Excavations at Saqqara, The Step Pyramid*, Le Caire: Services des Antiquities de l'Egypte, 1935, Vol. II, Pl. 95, 17.

7/Petrie, *Measures and Weights*, p. 17.

See Appendix A, pp. 200-204 for additional photographs of Egyptian weighing machines, a water-clock, and a Nilometer, which may be seen at the Metropolitan Museum of Art, New York City.

The Babylonian System

Thus different systems of measures and weights gradually evolved. Many metrologists believe that, in spite of the great antiquity of both the Babylonian and Egyptian systems, there was an even earlier source, or parent system, common to both. The marked similarity of the units, together with the etymology of their names, seems to support this theory.[1/] Apparently, the ancient Sumerian civilization provided, through trade and commerce over the whole then civilized world, the basis of the early Chinese, Indian, Hebrew, Etruscan, and Russian systems, as well as those of adjacent nations.[2/] From the scale of King Gudea the breadth of the handpalm conventionalized (3.9 to 4.1 inches) was the fundamental of all Babylonian measures of length.[3/] Also in widespread use were the cubit of 5 handbreadths (19.48 inches) and the double cubit (38.97 inches), which later became the yard. One third of the double cubit became the foot. Measures of area were constructed by squaring the linear measures. The Babylonian measure of capacity, the ka (approximately a quart) was derived, some authorities think, from a cube, which was a handbreadth in length. This cube filled with water gave the most important unit of weight, the great mina, which equaled 60 shekels. One shekel equaled 360 shes or grains of corn.[4/] Obviously the metrology of the Babylonians, like their numerical notation, was based on the sexagesimal concept.

The Egyptian System

In Egypt, the most important unit was the royal, or building cubit

1/Hallock and Wade, op. cit., pp. 9, 22.

2/Petrie, Measures and Weights, p. vi.

3/Hallock and Wade, op. cit., p. 13.

4/Ibid., pp. 15-16.

of 7 palms (20.62 inches).[1] Second in importance was the remen of 20 fingers (14.58 inches), which was the basis of land measure.[2] Some metrologists believe the later Mediterranean standards were based in general on these two measures.[3] The principal capacity measure in Egypt was the hekt, which was equal to 1/30 of the cubit cubed. The deben (1400 to 1500 grains) seems to have been the weight in most widespread use.

The Greek System

In Greece the fundamental unit of length was the Olympic foot (12.14 inches), which was used throughout the country. The main hall of the Temple of Athena in the Parthenon was called, according to Plutarch, Hekatompedos (one hundred feet).[4] The Olympic cubit was 1 1/2 times the foot (18.23 inches), and four cubits made an orguia or fathom (approximately the distance between the tips of the fingers when the arms are extended). One hundred orguias made a stadion, which originated, tradition says, as a natural measure, being the distance a strong man could run without stopping for breath. It was later fixed as the length of the Olympic stadion or athletic track (600 feet).[5] One hundred Olympic feet equaled one plethon, the square of which was used as a measure of area. The unit of weight in early Greece was the heavier Babylonian talent, which was equal to the weight of a cube of water whose edge was one Olympic cubit (18.23 inches). Subsequently Solon (c. 592 B.C.) established the Athenian talent, which was

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1/Petrie, Measures and Weights, p. 3.

2/Petrie, Social Life in Ancient Egypt, Boston: Houghton Mifflin Company, 1923, pp. 155, 156.

3/Hallock and Wade, op. cit., p. 5.

4/Ibid., pp. 23 - 25.

5/Edward Bernard, De Mensuris et Ponderibus Antiquis, Oxford, 1688, p. 226.

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1/Petrie, <u>Measures and Weights</u>, p. 5.

2/Petrie, <u>Social Life in Ancient Egypt</u>, Boston: Houghton Mifflin Company, 1923, pp. 135, 155.

3/Hallock and Wade, <u>op. cit.</u>, p. 5.

4/<u>Ibid.</u>, pp. 23 - 25.

5/Edward Bernard, <u>De Mensuris et Ponderibus Antiquis</u>, Oxford, 1688, p. 226.

3/5 of the old Babylonian one. This later talent was divided into 60 minas, each of which equaled 100 drachmas. One-third of a drachma gave a gramma. For liquid measure the unit was the metretes (approximately 39 quarts). One metretes equaled 12 amphora, each of which was approximately 3 quarts. The unit of dry measure was a medimnos (approximately 52 1/2 quarts). A medimnos was subdivided into 6 modius, each of which contained 8 choinix. This last mentioned measure was approximately one quart.[1/]

The Roman System

There is a close connection between the Roman and Greek measures and weights. The foot (11.65 inches)[2/] was the most important unit of the Roman system, as its use extended throughout Europe, due to conquests and the influence of the Empire. It has survived almost everywhere in some form. In fact it is the most widespread standard known.[3/] Another unit of length, which should be noted, is the cubitus or ulna to which may be traced the names "aulne" and "ell." The Roman unit of weight, the libra (pound), was also a very important standard, because of its influence on all later systems. Both the foot and the pound were divided into 12 unciae, from which may be traced the words "inch" and "ounce." In fact the Romans used duodecimal subdivision for all their standards, whether of length, weight, surface, or capacity.[4/] From the subdivisions of the pound may be traced the names of the apothecaries' measure in use today. The unit of liquid capacity was the amphora, which equaled a cubic foot, containing 80 librae

1/Hallock and Wade, op. cit., pp. 25, 27.

2/Ibid., p. 38.

3/Petrie, Measures and Weights, p. 6.

4/E. Noel, Natural Weights and Measures, London: Edward Stanford, 1889, p. 5.

(pounds) of water. For dry measure the unit was a modius, which equaled one-third of an amphora. The unit of area was the pertica or decempeda (10 feet) squared. This pertica squared and multiplied by 12 gave the actus, which, doubled, gave the jugerum or Roman acre (0.623 acre).[1/]

The English System

With the decline of the imperial power of Rome, the local systems of weights and measures, which had been based upon the Roman standards, ceased to be uniform, until throughout Europe there was considerable variation in the values of units. Prehistoric England, some metrologists believe, got from the East,[2/] through Asia Minor and Egypt, across the Mediterranean and via Rome, Germany, and the Belgic tribes the northern foot (13.0 inches) used in laying out the neolithic mound of Silbury Hill, and the Italic foot (11.68 inches) on which Stonehenge and other British circles were planned.[3/] From the Arabs, some authorities think, the Britons learned the use of barleycorns for measuring length and weight.[4/] Little more than this is known about the source of British weights and measures.

1/Hallock and Wade, op. cit., pp. 26-28.

2/Nicholson in Men and Measures suggests that the story of the yard, foot, and inch may be traced back through more than sixty centuries into the dawn of civilization. They evolved probably from the convenient standard afforded by a part of the human body--the length of the bent forearm from the elbow to the tip of the middle finger. This common cubit (18.24 inches) originating perhaps in Chaldea, is thought by some authorities to have been deduced by astronomers from the measurement of the earth, the quarter-meridian distance between the pole and the equator. Doubtless it spread into Egypt, and thence throughout Europe. The yard probably originated from the double cubit, while the foot developed as a measure from the cubit--one-third of the double cubit, or yard. This corresponded very conveniently to the length of a man's foot; the foot was divided into 16 finger-breadths, or digits, and into 12 thumb-breadths, or inches.

3/Petrie, Measures and Weights, pp. vii, 5. See also Chaney, op. cit., p. 16.

4/Hallock and Wade, op. cit., p. 29.

The Saxon conquerors, some authorities believe, brought their own yard, pound,[1] and bushel over from the continent, and, since the Romans gained little or no power over them, they were able to preserve these standards.[2] In the tenth century the Saxon King, Edgar, seeking to secure uniformity, decreed that the measures of Winchester were to be the standards, so that there should be the same money, the same measures, and the same weight throughout all his kingdom.[3] After the Norman Conquest, William the Conqueror's decree that, "The measures and weights shall be true and stamped in all parts of the country, as had before been ordained by law,"[4] recognized and preserved these Saxon standards. The Winchester measures were then taken to London, and put with the royal treasures in the Exchequer. Thus the Saxon yard (geard, gyrd, girdle) was used as a unit of land measure in the Doomsday Book (1086). It was also called virga or verge and was the same as the ell (ulna or aulne). These words found in the Latin and Norman French laws and official documents denote the same unit of length.[5] Somewhat later in the twelfth century, the standard for long measure was adjusted from the ancient ulna. This unit, the yard, has not been altered, merely revised, since that time.[6]

1/Rogers Ruding, Annals of the Coinage of Britain, London: Nichols, Son and Bentley, 1817, Vol. I, p. 12.

2/Chaney, op. cit., p. 17.

3/David Wilkins, Leges Anglo-Saxonicae, London: William Bowyer, 1721, p. 78. See also Bishop Fleetwood, Chronicon Preciosum, London: T. Osborne, 1745, p. 27.

4/Wilkins, op. cit., p. 228.

5/Chisholm, op. cit., p. 48 et seq. See also Ruding, op. cit., Vol. I, p. 206.

6/Kelley, op. cit., p. xx.

Uniformity was again emphasized in the section of the Magna Charta (1215) relating to measures and weights. This provided that throughout the realm there should be one measure of wine, ale, and corn--the quarter of London; and that it should "be of weights as of measures."1/ In the same century one of the earliest statutes (51 Henry III, 1266, "Assize Panis et Cervisiae") defined the royal pound of the Tower of London (5400 grains of wheat), based on the ancient pound of the Saxon kings kept in the Tower, their principal mint.2/ It says,

> "That by the consent of the whole realm of England, the measure of our Lord, the King, was made, viz., an English penny, called a sterling, round and without any clipping, shall weigh thirty-two wheat-corns in the midst of the ear; and twenty pence do make an ounce, and twelve ounces a pound; and eight pounds do make a gallon of wine, and eight gallons of wine do make a bushel, which is the eighth part of a quarter."

The Tower pound, however, was used for weighing gold, silver, and medicines, while the commercial or merchant's pound (libra mercatoria) was used for all other commodities. This latter pound was established in 1270 to weigh 6,750 grains, but as early as 1303 the avoirdupois pound of 7,000 grains replaced the merchant's pound.3/ Two years later Edward I (Statute 33) provided that an inch should contain "three barleycorns laid end to end,"4/ and Edward II (Statute 17) in 1324 added that 12 inches make a foot, and 3 feet make a yard (ulna).5/ The Troy pound of 5,760 grains

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1/Hallock and Wade, op. cit., p. 32.

2/Ruding, op. cit., Vol. I, p. 12.

3/Petrie, "Measures and Weights," Encyclopaedia Britannica, 14th ed., Vol. XV, p. 136.

4/Chaney, op. cit., p. 24.

5/Hallock and Wade, op. cit., p. 36.

(probably named for the French commercial town of Troyes) slowly made its way in England after the victory at Poitiers, and the English occupation under the Black Prince. It finally displaced the Tower Pound, which was abolished as a legal mint weight in 1527 by an Ordinance of Henry VIII. In Act 12, legalizing the standards which Henry VII had ordered made in 1495, the king also "did make weights and measures according to the old standards thereof remaining within his treasury."1/ About a hundred years later Queen Elizabeth had a more accurate and complete set of Exchequer standards constructed of bell-metal, adding in 1601 the ale gallon of 282 cubic inches. At the end of another hundred years (1707) Queen Anne added the wine gallon of 231 cubic inches. These Exchequer standards were used for regulating all weights and measures in England until 1824.

A Weights and Measures Committee of the House of Commons made a study of, and recommended changes in, the old English standards as early as 1758. A new standard yard and Troy pound of brass were constructed under their direction, but these were not legalized until 1824 (Act 5, George IV), when they were declared the only "original and genuine standards," from which all imperial measures and weights should be derived. Unfortunately, these two primary standards were destroyed, when the Houses of Parliament were burned some ten years later.2/ Consequently another Standards Commission

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1/It is interesting to note that these standards are still in existence. Chisholm, op. cit., p. 55 et seq.

2/Ibid., p. 65 et seq.

Ironically enough this fire was caused by the burning of tally sticks, which had been unclaimed for a thousand years or more. A specimen of this ancient English measure, one of the earliest in existence, being used in the ninth century or before, may be seen in the Dale Collection, Columbia University, New York City. This stick is of hazelwood, about eight inches long and three-eighths of an inch wide. When a person deposited money in

was appointed (1843) to restore the lost standards. As copies of the yard had been most carefully compared with the original, these were used in constructing the new standard. The most important recommendation of the committee was that the avoirdupois pound be adopted as the Parliamentary standard of weight in place of the Troy pound, which was practically unknown to the great mass of British people. The new imperial standard pound was made accordingly of platinum, weighing in a vacuum 7,000 grains.1/

The Metric Act of 1864 made these weights and measures legal in England. They have been and are little used, however, except for some scientific work.

The latest important event in the history of the English system of weights and measures is the finding by scientists (Messrs. J. E. Sears, Jr. and H. Barrell) at the National Physical Laboratory of Great Britain that one yard equals 1,419,813.31 wave-lengths of the red ray of cadmium light. Hereafter this fundamental unit of length may be redetermined with scientific precision from that finding.2/

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the Exchequer, the tally clerk cut notches in the stick--deep ones for pounds sterling, small ones for shillings, and scratches or slits for pennies. The depositor's name and the date in old English script or abbreviated Latin on two sides of the stick were written with a quill pen, dipped in gall-nut juice. Then the stick was sawn at a point a short distance from the opposite end, and split lengthwise into two pieces. The butt-end was kept by the Exchequer, as a record of the transaction, while the depositor kept the smaller one as his receipt. Each piece had exactly the same number of notches and scratches, as well as the depositor's name and the date. Since no other stick could be split to match either piece, counterfeiting was impossible. When the depositor wanted his money, he took his piece of the tally stick to the Exchequer, where the corresponding part was found, and the two fitted together; then the amount indicated by the notches and scratches was paid by the Exchequer. The last recorded payment of this kind was made in 1828. Records of a Universal Science, Boston: Business Historical Society, Baker Library, Soldiers Field, 1929, Vol. III, No. 2, pp. 12, 13.

1/Chisholm, op. cit., p. 69 et seq.

2/Walter Renton Ingalls, Modern Weights and Measures, New York: American Institute of Weights and Measures, 1937, pp. 6, 7.

The French System

In France during the time of Charlemagne (768-814 A.D.) the "pied de Roi" (12.79 inches) was established as a unit of length and the "livre esterlin" (5,666 grains) as a unit of weight.[1/] Reproductions of these standards were distributed throughout the realm in an effort to bring about some uniformity. The "toise de maçons" of Paris (6 feet) was also used widely at this time. Philip I in the eleventh century established a marc, weighing eight ounces of the "livre esterlin." This marc was doubled by King John the Good (1350), and his standards, adjusted according to the weights of Charlemagne, were called the "pile de Charlemagne." These remained the royal standards of France for nearly four hundred and fifty years, until the metric system was adopted.[2/] During the fourteenth or fifteenth century the "livre de Troyes" and the "avoirdupois" pound began to be used for commercial purposes. In 1554, the aune, or ell (46 inches), based on the standard of the Guild des Marchands, Merciers, et Grossiers, was adopted as a unit of linear measure for cloth. This was used until displaced by the mètre. In the seventeenth century the "toise du Grand Châtelet," which was half the distance (6 feet) between the walls of the inner gate of the Louvre, and was based on the ancient "toise de maçons" was used as a unit of length.[3/]

Lack of uniformity and corruption of the old French system of weights and measures caused the study of reforms long before the Revolution. Gabriel

1/Tradition says the "livre esterlin" was based on the Arab "yusdruma" sent Charlemagne by the Caliph Al-Mamun. Hallock and Wade, op. cit., p. 37 et seq.

2/Chisholm, op. cit., p. 111.

3/J. B. Souquet, Métrologie Française, Toulouse: Chez Martegoute, 1840, pp. 1, 2.

Mouton in 1670 proposed a geometric decimal system, based on the length of an arc of one minute of the earth's circle. He further defined this geometric foot as equal to the length of a pendulum, making 3,959.2 vibrations in a half hour at Lyons. Jean Picard, the astronomer, also suggested in 1671 an astronomical radius (rayon astronomique), which would be the length of a pendulum, beating seconds of mean time. One third of this would be the universal foot, and doubling the astronomical radius would give the universal toise (fathom). Huygens (1673) offered a similar proposal.[1/] Later in 1720 Cassini suggested, in "De la Grandeur et de la Figure de la Terre," a geometric foot (pied geométrique), which would be equal to 1/100 of the arc of one minute of the terrestial meridian. Six pieds would equal one toise.[2/] Du Fay presented another plan, using the second's pendulum as a unit. After his death La Condamine (1747) elaborated this scheme, providing against variation in the length at various latitudes by using a pendulum at the equator in Quito, Peru. Du Vernois at about this time also, proposed the use of a second's pendulum, taking the length at a single point, at the Royal Observatory in Paris. One third of this length would then be the French (natural) foot. Thus did many scientists during the seventeenth and eighteenth centuries offer proposals for the improvement of weights and measures.[3/]

In the year 1790, once more, during the first months of the Revolution, Prince de Talleyrand,[4/] Bishop of Autun, who was interested in unification,

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1/Christian Huygens, Horologium Oscillatorium, Pars Quarta, Propositio XXV, pp. 151-156.

2/Bigourdan, op. cit., pp. 6, 7.

3/Hallock and Wade, op. cit., pp. 43-45.

4/Talleyrand suggested corresponding with British authorities on the subject of international uniformity of weights and measures. Le Systême Métrique Décimal, pp. 2, 3.

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1/Christian Huygens, Horologium Oscillatorium, Pars Quarta, Propositio XXV, pp. 151-155.

2/Bigourdan, op. cit., pp. 6, 7.

3/Hallock and Wade, op. cit., pp. 42-45.

4/Talleyrand suggested corresponding with British authorities on the subject of international uniformity of weights and measures. Le Système Métrique Décimal, pp. 2, 3.

brought the matter to the attention of the National Assembly.[1] All that was actually required was that some changes should be made in the Paris system, and that this revised system should be put into nation-wide use. As Napoléon later remarked, "It was so simple that it could have been done in twenty-four hours, and adopted throughout France in less than a year."[2] The National Assembly, however, decreed that a study of the existing measures and weights should be made, and referred the demand for an improved system, based upon a natural unit, to the Académie Royale des Sciences. This study was never completed or reported on, but the metric system was created. It was a direct by-product of the French Revolution and its back-to-nature philosophy, based on Rousseau's "Social Contract." The doctrinaire theorists wished "to create them [the weights and measures] anew on invariable bases, and to establish in commercial calculations the uniformity, which Reason has vainly called for, during so many centuries, and which must form a new bond between men."[3] Incidentally, such uniformity would be a valuable aid in the unification of the République, and one more bulwark for the centralization of power, a concern of paramount importance to those ruling at the time. So it was decided by the "idéologues," as Napoléon styled them, "those builders of theories for an imaginary world," as Talleyrand characterized them--the mathematicians and other scientists, to whom the formation of a "Républicain" system of measures and weights was entrusted, that the fundamental unit of the new system, the mètre, should be one ten-millionth of the distance from the pole to the equator on the terrestrial meridian which passes through Paris.

1/Chisholm, op. cit., p. 98.

2/Mémoires de Napoléon, Paris: Firmin Didot Père et Fils, 1824, Vol. IV, p. 213.

3/Nicholson, op. cit., p. 271 et seq.

A report was made in 1792 giving the names, which had been carefully selected by a lexicographer, for all the measures, together with Greek and Latin derivations worked out to indicate the multiples and subdivisions on a decimal basis, but no values were given for the units. The report,[1/] nevertheless, was adopted unanimously, and without debate. No one apparently stopped to consider whether or not this decimal system, so convenient for mathematical theorists, would be equally so for the great mass of tradesmen, who would actually need to use the weights and measures. In 1793 a provisional mètre (3 feet 11.442 lines) based on the 1740 survey was adopted, while the law of the 18 germinal in the year III (April 7, 1795) established the metric system.[2/] The length of the mètre was changed in 1799 to 3 feet 11.296 lines, after the quadrant distance had been redetermined by measuring the distance between the cities of Dunkerque and Barcelone, situated on the Paris meridian, and calculating the quarter meridian.[3/] This was found to be 5,130,740 toises. The ten-millionth part of this length was adopted as the mètre. Thereupon all other systems of measures and weights were forbidden, and severe penalties were imposed if they were used. Unfortunately, later measurements proved that the 1799 mètre was not one ten-millionth part of the meridian quadrant, and so in 1869 the French government had to define it empirically as the length of a certain bar.[4/] This action was

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1/Wilson read and reported on this document. See Guy M. Wilson, Mildred B. Stone, and Charles O. Dalrymple, Teaching the New Arithmetic, New York: McGraw-Hill Book Company, Inc., 1939, p. 259.

2/Pierre Chenevier, Précis d'Arithmétique, Paris: Hachette, 1928, p. 204.

3/Pierre François André Méchain et Jean Baptiste Joseph Delambre, Base du Système Métrique Décimal, Paris: Baudouin, 1810, Vol. III, pp. 592-655.

4/P. Camman and J. Huot, Cours Élémentaire d'Arithmétique, Paris: J. De Gigord, 1923, p. 225.

taken by the French government at the recommendation of La Section Française of La Commission Internationale du Mètre, preceding the first meeting of the International Metric Commission which opened in Paris September 1, 1869. It was a method of avoiding embarrassment over new measurements, by German, British, and Russian scientists showing a new determination for the length of the mètre based upon one ten-millionth part of the meridian quadrant.[1]

Napoléon, seeing that the metric system was not working successfully, decreed in 1812 that the existing standard units should remain, but that "such fractions and multiples as were generally used in trade, and were best suited to the needs of the people" should be used. Being too wise to disturb trade again by making a change in the primary standards, he did, however, abolish the unpopular decimal series, and thus established the "usuelle" system.[2] This decree was in force until January 1, 1840, when the use of metric units again became obligatory, with severe penalties for the use of any other measures and weights.

The International Bureau of Weights and Measures was established in 1875 at the instigation of the French government. Three years later the Observatoire at Saint-Cloud was completed and the international prototypes were deposited there for safe-keeping.[3] In 1927 at the Seventh International Conference on Weights and Measures it was agreed to accept as the most accurate determination to date of the length of the mètre 1,553,164.13 wave-lengths of the red ray of cadmium light, a British contribution. From this finding the length of the mètre may be redetermined at any time with

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1/Le Système Métrique Décimal, pp. 76-86. See also Bigourdan, op. cit., p. 255; and Hallock and Wade, op. cit., p. 69.

2/Nicholson, op. cit., p. 284.

3/Hallock and Wade, op. cit., p. 75 et seq.

great accuracy.[1]

Weights and Measures in the United States

When European colonization began in the new world on the North American continent over three hundred years ago, the colonists naturally transplanted the weights and measures with which they were familiar: Spanish, Swedish, Dutch, and French, as well as English. As soon as England had established her supremacy along the Atlantic seaboard, some colonies enacted statutes providing for standards, derived from those of the Exchequer. Thus the yard, the avoirdupois pound, the wine gallon (231 cubic inches), and the Winchester corn bushel (2,150.42 cubic inches) of the English system were the principal units used,[2] and copies, more or less authentic, were brought over, and adopted by the several colonies. Consequently divergencies in weights and measures became quite common.[3]

After the revolt of the thirteen English colonies, one of the first moves of the American revolutionists in the direction of unification and centralization of power was to attempt to establish a uniform national system of weights and measures. Therefore the Articles of Confederation, which the Continental Congress adopted in 1777, provided that, "The United States in Congress assembled shall also have the sole and exclusive right and power of....fixing the standard of weights and measures throughout the

1/Ingalls, op. cit., p. 7.

2/This gallon and bushel were used in Great Britain until 1824 when by a royal decree they were superseded by the present imperial gallon and bushel. The United States, however, continued to use the wine gallon and the Winchester corn bushel.

3/The Metric versus the English System of Weights and Measures, National Industrial Conference Board, Inc., Research Report No. 42, New York: The Century Company, 1921, pp. 36-43.

United States...."[1] Later after the successful termination of the Revolution, in the Federal Constitution, Congress is explicitly given the power to "fix the standard of weights and measures."[2]

In his first message to Congress, Washington referred to this subject as one "of great importance" which should be "duly attended to." Accordingly in 1790, the House of Representatives requested Thomas Jefferson, Secretary of State, to prepare a report on this subject. It is interesting to note that although he had been in Paris as United States Minister and so was familiar with the metric system, he did not advocate its adoption.[3] In his "Plan for Establishing Uniformity in the Coinage, Weights, and Measures of the United States" he gave two complete and distinct plans--[4] neither of which he especially championed. Instead he left the matter entirely to Congress[5] which did nothing except appoint in 1792 a Senate Committee. Finally in 1793, Congress decided "that the standards should be the mean of those found in the country."[6] No legislative action, however, was taken.

Twenty-one years later, needing some standard of length, the Coast and Geodetic Survey imported from London a brass bar scale of 82 inches. The standard United States yard (36 inches on this scale between the 27th and

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1/Harper's Encyclopaedia of United States History, New York: Harper and Brothers, 1915, Vol. II, Articles of Confederation, Article IX.

2/*Ibid*., Constitution of the United States, Article I, Sec. 8.

3/Thomas Jefferson, The Writings of Thomas Jefferson, New York: J. C. Riker, 1856, Vol. III, p. 276; Vol. VI, p. 11; Vol. VII, p. 87.

4/*Ibid*., Vol. VII, pp. 477, 488.

5/Hallock and Wade, *op. cit*., p. 114.

6/*Ibid*., p. 113.

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1/Report of the Superintendent of the United States Coast Survey, June, 1877, Washington: Government Printing Office, 1880, pp. 149-154.

2/John Quincy Adams, Report upon Weights and Measures, Philadelphia: Abraham Small, 1821, p. 81.

3/National Industrial Conference Board, Inc., Research Report No. 42, op. cit., p. 39.

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procured from London a year previous, as the standard of the United States Mint. From this was derived the standard avoirdupois pound of 7000 grains.

Due to lack of uniformity in the standards used by the various customhouses, as shown in the examination by the Treasury Department when these weights and measures were called in, Congress provided that there should be constructed in the office of the Coast Survey complete sets of standards for every state and territory, as well as for the customhouses. By 1836 the latter had been supplied, while the states were by 1856. As adopted by the Treasury Department the avoirdupois pound was 7000 grains; the yard 36 inches; the gallon 231 cubic inches; and the bushel 2,150.42 cubic inches. Individual states enacted statutes, establishing these as standards of weights and measures. Thus was accomplished the simplification of existing weights and measures and the issuance of correct standards, as Adams had recommended in his report of 1821.

To replace the old Office of Weights and Measures of the Coast and Geodetic Survey, the National Bureau of Standards, with large and up-to-date laboratory equipment, was established in 1901.

As early as 1848 the introduction of metric weights and measures through the elementary schools was urged by Professor Bache, while in 1864 the state of Connecticut recommended to the proper school officers that they should provide for the teaching of metric units in all the schools. From these beginnings can be traced the drill on, and enforced memorization of, the metric weights and measures. The use of metric units in the United States was made legal by an Act of Congress July 28, 1866,[1/] due in part at least,

1/Public Laws of the United States of America, Passed at the First Session of the Thirty-ninth Congress; 1865-1866, Boston: Little, Brown, and Company, 1866, Ch. 301, p. 339. See also Appendix B, pp. 207-208.

to their adoption by the Latin American countries, during the previous ten years. At this time, also, acts were passed authorizing their use by the Post Office Department and authorizing the Treasury Department to furnish metric weights and measures to the several states. The French government in 1871 invited the United States to send delegates to an international convention held in Paris for the purpose of constructing new metric standards. As a result of this, the United States, together with eighteen other nations, agreed to establish and support the International Bureau of Weights and Measures. Thus in 1875 this bureau was established not far from Paris at Saint-Cloud in the pavillon de Breteuil. Eighteen years later, having completed international prototype standards of the standard metre and kilogramme, the bureau distributed sets to each of the nineteen participating nations.[1/]

In 1893 Congress passed an act establishing a standard gage for sheet and plate iron and steel.[2/] This scale was expressed in both customary and metric measures. The following year an act[3/] defined and established units of electrical measure.

Since 1866, when the first permissive metric legislation was passed, various metric bills have been introduced into Congress, the most important[4/] of these being H.R. 123, which was introduced in 1903; the Ladd Bill[5/]

1/National Industrial Conference Board, Inc., Research Report No. 42, op. cit., p. 41. See also Le Système Métrique Décimal, p. 108.

2/The Statutes at Large of the United States of America, Washington: Government Printing Office, 1893, Vol. XXVII, Ch. 221, p. 746.

3/Ibid., Vol. XXVIII, Ch. 131, pp. 101, 102.

4/See Appendix B, p. 209, for the proposed bill.

5/See Appendix B, pp. 209-212, for the proposed bills.

(S2267) of 1921; and the Britten Bill of 1926. In general, all of these bills would make metric weights and measures compulsory for official governmental use, and would extend their use gradually to the public. In every instance there has been such strong concerted opposition, particularly from business men, manufacturers, and engineering societies, to any such legislation that none of these bills has been enacted.

In conclusion it should be noted that the English system lends itself quite as well to refined measuring as do metric units. The following are some of the practical measurements which are being used in industry:

Mazda lamp filaments which are made to an accuracy of one ten-thousandth (.0001) of an inch by the General Electric Company, Schenectady, New York;

Parts of moving-picture cameras which are made to an accuracy of one ten-thousandth (.0001) of an inch;[1]

The thickness of electroplated protective coatings which is expressed in terms of one hundred-thousandth (.00001) of an inch;

The profilograph which can detect and measure surface irregularities to within one millionth (.000001) of an inch made by the Timken Roller Bearing Company, Canton, Ohio;

Light wave measurements to millionths of an inch used by the Bausch and Lomb Optical Company, Rochester, New York;

The Johansson gage block, the most refined type of which is accurate to two millionths of an inch, used by the Ford Motor Company, Detroit, Michigan;

The thickness of a film of stearic acid which has been found to be one

[1] John J. Floherty, Movie-makers, New York: Doubleday, Doran, and Company, 1935, pp. 13-16.

ten-millionth (.0000001) of an inch by Dr. Irving Langmuir, Associate Director of the General Research Laboratories at Schenectady, New York;

An instrument developed in the physical laboratory of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pennsylvania which can measure stretches in steel to one hundred-millionth (.00000001) of an inch;

A scale graduated to one hundred-thousandth (.00001) of a pound, which can be read to five-millionths of a pound (.000005) used by the Barnes-Gibson-Raymond Company, Detroit, Michigan; and

An electronic timer which gives readings in terms of a thousandth (.001) of a second designed by the General Electric Company, Schenectady, New York.[1/]

The writer, November 28, 1938, visited the works of the Brown and Sharpe Manufacturing Company at Providence, Rhode Island. This concern is one of the largest manufacturers and distributors of machine tools, machinists' small tools, and precision machinery in the world. Their catalog lists over 6500 different sizes and types. Among these are micrometers, a large number of which measure to one ten-thousandth part of an inch and Vernier calipers, which measure to one one-thousandth of an inch. In the inspection room, where gages and precision tools are inspected at a constant temperature of 68 degrees Fahrenheit, there are some machines capable of measuring finer than one one-hundred thousandth part of an inch and one machine which checks the accuracy of the lead of micrometer screws within two millionths of an inch. All of these measuring machines and the

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1/Ingalls, op. cit., pp. 57, 58.

equipment used in this room are periodically inspected and adjusted to precision standards calibrated by the National Bureau of Standards at Washington, D. C.

The Norton Company of Worcester, Massachusetts, a large manufacturer and distributor of grinding and lapping machines and machine tools, whose shops the writer visited August 6, 1940, ordinarily use a tolerance of one ten-thousandth of an inch on many of their parts, not only for dimensional accuracy but for surface roughness as well. In their laboratory they, like Brown and Sharpe, have machines, which measure one millionth of an inch.

A third machine shop,[1] which the writer visited August 12, 1940, was that of the Pratt and Whitney Division of the Niles-Bement-Pond Company in Hartford, Connecticut. This company is one of the largest and most important manufacturers in the United States of gages, small tools, machine tools, and precision machinery. In the manufacture of the last mentioned there are many requirements where dimensions and tolerances are expressed to one ten-thousandth of an inch. For gage work, dimensions and tolerances are specified in one hundred-thousandths of an inch, while for precision gage blocks, the measurements are held to accuracies of millionths of an inch. On the work bench and in the laboratory comparators are used which are read directly

1/These three companies were chosen as representative in this field because they are among the largest and most important manufacturers in the world of machinery and precision tools, and consequently do a large export business, having world-wide connections. Brown and Sharpe Manufacturing Company has approximately 6,300 employees, and the Providence plant is the largest of its kind in the world. The Norton Company has the following foreign subsidiaries: Norton Company of Canada, Ltd., Hamilton, Ontario; Cie. des Meules Norton, La Courneuve, France; Deutsche Norton Gesellchaft, Wesseling, Germany; S. A. Mole Norton, Corsica, Italy; and Norton Grinding Wheel Company, Ltd., Welevyn Garden City, England. This company's net working capital is approximately 12 million dollars, and the Worcester plant alone has 4,000 employees. The Niles-Bement-Pond Company, of which the Pratt and Whitney division is a part, has 2,364 employees, while the Pratt and Whitney Aircraft Company employs 11,000 more. (1940)

to five millionths of an inch.

The Portuguese System

Weights and measures in Portugal, like those of Rome and Greece, were based on the ancient systems of Egypt and Babylonia. Most important was the palmo or span (8.66 inches) which was made up of 8 polegadas or thumbs (1.08 inch). Five palmos equaled a vara or yard (1.20 yard), and 2 varas made a braça (7.21 feet). The covada or cubit of 3 palmos (25.97 inches) also was used, as well as the dedo or finger of 8 linhas (0.72 inch). The Portuguese milha was 1.28 mile. The unit of area was the square palmo (0.52 square foot). The geira was 4,840 square varas (1.45 acre). For liquid capacity the unit was the alqueire (pote or cantaro) which was approximately 2 gallons. Two alqueires made one almude (4.37 gallons). The unit of dry capacity was the alqueire (0.37 bushel). Four alqueires made one fanga (1.49 bushel). Timber was measured in cubic polegadas; masonry in cubic palmos; and earthwork in cubic braças. The unit of weight, the arratel or pound (1.01 pound) was made up of 16 onças (ounces), each of which contained 8 outavas.1/ The arroba (32.38 pounds) was made up of 32 arratels, and 4 arrobas made a quintal (129.52 pounds).2/

By decree metric units were introduced into Portugal in 1852. The people, however, did not want them, and refused to abandon the customary weights and measures. A subsequent statute was necessary, making metric usage compulsory in 1872, but in spite of penalties the old units are still used.3/

1/Outava (55.34 grains).

2/W. S. B. Woolhouse, The Measures, Weights, and Moneys of All Nations, London: John Weale, 1859, pp. 89-90.

3/Hallock and Wade, op. cit., pp. 94, 106. See also National Industrial Conference Board, Inc., Research Report No. 42, op. cit., pp. 25-26.

The Spanish System

The Spanish system is similar to the Portuguese, but varies from the English even less. Its unit of length, the pie or foot (10.92 inches), was made up of 12 pulgadas or thumbs (0.91 inch). Three pies made one vara or yard (0.91 yard). Other units of length were the dedo or finger (0.7 inch), made up of 9 lineas or lines; the palmo or span (8.35 inches), containing 12 dedos; and the legua of 8000 varas (4.22 miles). For liquid capacity the unit was quartillo (0.11 gallon), made up of 4 copas. Four quartillos made one azumbre (0.44 gallon), eight of which made one arroba or cantaro (3.54 gallons). The standards of the arroba were 34 libras (pounds) of water and 25 libras of oil. The unit for dry capacity was a medio (0.06 bushel), containing 2 quartillos.1/ Two medios made an almude (0.13 bushel), and 12 almudes were one fanega (approximately 1 1/2 bushel). A cahiz (2.33 quarters) was 12 fanegas. For weight the unit was a libra or pound (1.01 pound). This was made up of 16 onzas or ounces, and 8 ochavas or dracmas made an onza.2/

In 1849 metric units were adopted in Spain, but their use was optional until 1855 when metric usage was made compulsory. The period of compulsory adoption was nominally 3 1/2 years, but actually 19 1/2. The wishes of the people were not consulted when the change was made, and they resorted to that unspectacular, but very effective weapon, passive resistance, as the subsequent laws of 1892 and 1917 show. Today after nearly a hundred years customary units are still used in Spain.3/

1/Quartillo (0.03 bushel)

2/Woolhouse, op. cit., p. 100.
Onza (443.8 grains)
Ochava (55.5 grains)

3/Hallock and Wade, op. cit., pp. 95, 106. See also National Industrial Conference Board, Inc., Research Report No. 42, op. cit., p. 26.

CHAPTER III

A SURVEY OF THE LITERATURE IN THE FIELD

Another important part of the background study is a survey of the literature which is related significantly to the problem.

I. Adams' Report

The John Quincy Adams' "Report upon Weights and Measures," prepared "in conformity to a resolution of the Senate of the third [of] March, 1817," is one of the greatest contributions in this field. Although written over a hundred years ago, it still holds its place unchallenged, as one of the most scholarly and unbiased treatments of the subject.

The Senate's resolution specified that the report should deal with the following three questions:

1. What have been the proceedings in foreign countries for establishing uniformity of weights and measures?

2. What are the regulations and standards for weights and measures in the several states of the Union?

3. What propositions relative to the uniformity of weights and measures should be adopted in the United States?[1]

Adams answers the first question by giving in some detail a history of English weights and measures. "From the earliest records of parliamentary history the statute books," he says, "are filled with ineffectual attempts of the legislature to establish uniformity. Considered as a whole, the

1/Adams, op. cit., p. 5.

established weights and measures of England are but the ruins of a system, the decays of which have been often repaired with materials adapted neither to the proportions, nor to the principles of the original construction." 1/ This survey of England's struggle for uniformity is followed by a history of the French metric system, which originated with the Revolution; was established by decree; and was suspended, for all practical purposes, after the decree of 1812.

The second "object of attention" designated in the Senate's resolution, "The regulations and standards for weights and measures in the several states of the Union," Adams deals with from the earliest Colonial times. Of standards he writes, "All the standards at the exchequer are the same that they were at the first settlement of Jamestown; with the exception of the wine gallon, which is of the time of Queen Anne /1707/: and the standards of the exchequer are the prototypes from which all the weights and measures of the Union are derived." 2/ He then discusses in detail the regulations and standards up to the date of this report for each of the following states: Massachusetts, New Hampshire and Vermont, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Kentucky, Tennessee, Ohio, Louisiana, Indiana, Mississippi, Illinois, Alabama, Missouri, and the District of Columbia.

In answer to the third question Adams says,

> "Of all the nations of European origin, ours is that which least requires any change in the system of their weights and measures. With the exception of Louisiana, the established

1/Ibid., pp. 21, 71.

2/Ibid., p. 94.

system is, and always has been, throughout the Union, the same....[1]

"To fix the standard of weights and measures of the United States as they now exist, it appears that the act of Congress should embrace the following objects:

"1. To declare what are the weights and measures to which the laws of the United States refer as the legal weights and measures of the Union.

"2. To procure positive standards of brass, copper, or such other materials as may be deemed advisable, of the yard, bushel, wine and beer gallons, troy and avoirdupois weights; to be deposited in such public office at the seat of government as may be thought most suitable.

"3. To furnish the executive authorities of every state and territory with exact duplicates of the national standards deposited at the seat of government.

"4. To require under suitable penal sanctions, that the weights and measures used at all the custom-houses, and land surveys and post offices, and, generally by all officers under the authority of the United States, in the execution of their laws, should be conformable to the national standards.

"5. To declare it penal to make, or to use with intent to defraud, any other weights and measures than such as shall be conformable to the standards".[2]

Adams then goes on to make specific and detailed suggestions in regard to each of the above five recommendations. He also submits

"to the consideration of Congress that, in the act for fixing the standard of weights and measures for the United States, together with a definition of the foot, its exact proportion to the standard mètre of France should be declared: to effect which purpose with the utmost attainable accuracy, it would be necessary to compare together the identical measure to be used hereafter as the standard linear measure of the Union, with the standard mètre in platina, deposited in the national archives of France".[3]

Summarizing the plan submitted to both houses of Congress for their consideration, Adams states that it consists of two parts:

1/*Ibid.*, pp. 92-93.

2/*Ibid.*, pp. 125, 126.

3/*Ibid.*, p. 130.

"1. To fix the standard, with the partial uniformity of which it is susceptible, for the present, excluding all innovation.

"2. To consult with foreign nations, for the future and ultimate establishment of universal and permanent uniformity."1/

II. American Society of Mechanical Engineers Report Number 972

A second outstanding contribution to the literature in this field was published in 1903 by the American Society of Mechanical Engineers, which in 1902, appointed a committee to discuss the arguments in favor of and against the metric system. Samuel S. Dale prepared the report.2/

"All the members of the committee were agreed upon the following points:

"1. Legislation designed to compel the exclusive use of the metric system is not desirable.

"2. We believe that such legislation could not be enforced in any event so far as transactions between private individuals are concerned.

"3. The general government has the power to specify the system to be used in its own work and business, and can require that work done for it by contractors shall conform to any specified measurements or weights.

"4. The government cannot compel anyone to bid upon its specifications.

"5. Recognizing the well settled fact that the consumer does and must pay all necessary costs of production, we believe that, if the government specifies such dimensions as will materially increase costs of production, the government and not the bidder will have to pay such increased costs, it being self-evident that a bidder, not compelled to bid, will not do so except at a price, which will afford him a profit.3/

"6. The bill4/ now before Congress is intended to make the

1/Ibid., p. 133.

2/Samuel Sherman Dale, "Committee Report No. 972 on the Metric System," American Society of Mechanical Engineers Transactions, New York, 1903, Vol. XXIV, pp. 630-712.

3/Ibid., p. 708.

4/See Appendix B, p. 209, for proposed bill.

use of the metric system compulsory in the several departments of the government, but it cannot make it compulsory in private transactions.1/

"7. We believe there is no force in that class of arguments, which consists in taking integral dimensions in one system; translating them into equivalent and therefore fractional dimensions in the other system; and then making comparisons. Such arguments can be made as strong for the one system as for the other."2/

The remainder of the report deals with the "arguments in favor of and against the metric system."

III. National Industrial Conference Board Report Number 42

Precisely a hundred years after the publication of the Adams' report the National Industrial Conference Board, which is a "cooperative body composed of representatives of national and state industrial associations, and organized in 1916 to provide a bureau of scientific research; a clearing house of information; a forum for constructive discussion; and machinery for cooperative action on matters that vitally affect the industrial development of the nation," published its masterly Research Report Number 42, "The Metric versus the English System of Weights and Measures." It deals with the question of substituting by compulsory law the metric for the English system in the United States. The facts and arguments bearing upon this are concisely presented, the authors aiming "to provide a basis for intelligent judgment....rather than to express an opinion."3/ It consists of three parts:

1. The history and present national status of the English, metric,

1/Dale, op. cit., p. 710.

2/Ibid., pp. 630, 631.

3/A Digest of the Metric versus the English System of Weights and Measures from Research Report Number 42, Special Report No. 20, New York: National Industrial Conference Board, Inc., 1921, p. 1.

and the other systems of weights and measures.

2. An analysis of the application of the English and metric systems to various specialized fields such as: science, engineering, manufacturing, and trade.

3. The arguments, set forth judicially, which are advanced by advocates of the metric and the English systems respectively for and against the compulsory adoption of the metric system by the United States.[1/]

IV. United States Hearings, 1922

The following year the "Hearings" on the Ladd Metric Bill, S.2267, which proposed "to fix the metric system of weights and measures as the single standard of weights and measures for certain uses,"[2/] were published. This pamphlet sets forth in detail again the metric controversy in the United States. The "Hearings" consist of three parts:

1. The arguments of the proponents of this bill.[3/]
2. The arguments of the opponents of this bill.[4/]
3. The rebuttal.[5/]

V. National Industrial Conference Board Report Number 34

Another important National Industrial Conference Board report appeared in 1926. It briefly gives the arguments for and against a change from our customary weights and measures to the metric system, which was proposed by

1/National Industrial Conference Board, Inc., Research Report No. 42, op. cit., p. iii.

2/See Appendix B, pp. 209-211, for proposed bill.

3/United States Hearings, 1922, op. cit., pp. 3-169.

4/Ibid., pp. 171-320.

5/Ibid., pp. 321-439.

a bill introduced in the House of Representatives on December 7, 1925, as H.R. 10.[1/] This bill would extend in the United States the permissive use of the metric system to its exclusive use "in all buying, selling, and transportation of goods, wares, and merchandise, as well as in all postage, excises, duties, and customs charged or collected by weight or measure by the United States government, except as otherwise indicated above." The effect of the enactment of such a bill would be virtually that the metric system would supersede, after July 1, 1935, the English system "in which practically all business negotiations in the United States are now conducted."[2/]

A summary of the analysis in the report of the arguments for and against the compulsory adoption of the metric system in the United States is as follows:

1. On the issue of the intrinsic merits of the two systems the arguments are

> "inconclusive..../because/ concrete and substantial evidence.... /is lacking, but/ the incontestable proof of superiority would be the ultimate ability of one system to prevail over the other, and to become universal in its application, even without the support of coercive measures....Either of the two systems, however, may have intrinsic merits, which may render it superior to the other in one field of endeavor, or another, or generally, but which may be insufficient to overcome established prejudices."[3/]

2. In regard to the extent of the present use of the metric system the evidence is "incomplete." An increasing number of countries have officially adopted the metric, but the English system is still in use in

1/See Appendix B, pp. 211 and 212, for proposed bill.

2/National Industrial Conference Board, Inc., Special Report No. 34, op. cit., p. 5.

3/Ibid., p. 12.

metric countries. Additional information, also, is needed concerning the difficulties involved, before any definite conclusion can be reached with respect to the importance and necessity for a uniform international standard.[1/]

3. "The experience of other countries does not afford a good criterion for determination of the probable effect of substituting the metric system for the present English system" because:

   a. Many of the countries are not industrialized.

   b. "In many cases the substitution took place prior to the extensive use of modern machine methods of production....

   c. "A high degree of standardization and quantity production characterizes American industry and differentiates manufacturing conditions in this country from those abroad," so that this change would not be simple and easy, and made by either the United States or Great Britain alone might have serious results upon the intimate economic relationship between these two countries.[2/]

4. The proposed change to the metric system "would involve very large costs," as well as great inconvenience. Therefore more reliable estimates should be made before this country is committed to "so momentous a change," and a more definite conclusion should be reached "as to whether this cost would be balanced by the benefits attributable to the use of the metric system and to the advantages of the universality of standard units." The length of time, due to obstacles resulting from changing the "ingrained habits of the people in their daily activities," required to effect the

1/*Ibid.*, p. 14.

2/*Ibid.*, p. 16.

change is an important element in the consideration of the cost.[1]

5. That, in spite of permissive legislation, "very little progress has been made in the last few decades in using the metric system in the industry and commerce of this country, and that its use in the field of science has in no way interfered with the continued use of the English system generally in industry, commerce and trade, transportation and finance," are important facts in considering the need for compulsory legislation.

6. The demand for a change "comes primarily from teachers and scientists," while there is "almost universal opposition among farmers, manufacturers, and business men," and "the public as a whole is definitely opposed."[2]

From the above it will be seen that there is a "general lack of agreement on all the important aspects of the problem," and that there are two main issues to be considered:

1. "The determination of the superiority of one system over the other....

2. "The analysis of the effects which would follow the compulsory adoption of the metric system in the United States, together with the consequent private and social cost."[3]

VI. <u>United States Hearings, 1926</u>

These "Hearings" before the Committee on Coinage, Weights, and Measures of the House of Representatives, Sixty-ninth Congress, First Session, record in detail, the testimony of the proponents and of the opponents of

1/*Ibid.*, p. 18.

2/*Ibid.*, p. 19.

3/*Ibid.*, p. 20.

the Britten Bill, H.R. 10, "extending the use of metric weights and measures in merchandising."[1] This bill together with a joint resolution (H.J.Res. 238) were voted down in the Committee during April, 1926.

For the convenience of the reader a brief summary of the most important arguments for and against the compulsory adoption of the metric system in the United States will be given here.[2]

Con	Pro
1. The metric system is superior because:	1. The English system is superior because:
a. Its fundamental units (meter, liter, and gram) are scientific in character and the relationship between them is simple.	a. Its fundamental units are natural and practical. Those of the metric system are not absolutely scientific, and there is not much practical value in having related measures of weight, length, and capacity. Furthermore, the correlation between cubic capacity and weight is as good in the English system as in the metric.
b. Its decimalization (multiplication and division) of units of the same measure: (1) Makes it easier to work with (computations simpler). (2) Avoids the mixture of binary and decimal fractions.	b. Binary and duodecimal multiplication and division are superior because common fractions can be visualized more easily and are easier to work with, for general practical use, than are decimals. The English system, furthermore, is adapted equally well to the use of both binary and decimal fractions, while the structure of the metric system is strictly decimal. Moreover, binary and other non-decimal fractions are used with the metric units everywhere. Therefore, fractions would not be abolished.

1/See Appendix B, pp. 211 and 212, for proposed bill.

2/National Industrial Conference Board, Inc., Special Report No. 34, op. cit., pp. 6-10.

Con	Pro
c. It has a smaller number of units in common use, and these names are learned and retained more easily.	c. It has fewer common units and their names, being of ancient origin are mostly monosyllabic, and therefore are more easily learned and remembered.
d. It is more easily understood, due to its simplicity of structure.	d. It is more easily understood because: (1) Its units fit and are associated with everyday needs and experiences. (2) It has a small number of units. The 1866 law legalized 28 of the original 45 metric units, and others have since been created. (3) Its units are of handy sizes, while the metric are inconvenient and unusable. (4) Its units have short names, which are easily memorized. The metric names are arbitrary combinations of Greek and Latin words.
e. It is more convenient and adaptable.	e. It is more convenient, adaptable, and comprehensive because of: (1) Its binary and duodecimal divisibility. (2) The practical relationship of its units. (3) Its adaptability to the requirements of progress, proved by the dropping of obsolete or obsolescent units.
2. The metric system is superior for and extensively used in special fields because:	2. The metric system has no demonstrated advantages, nor is it extensively used in special fields since:
a. It is of greater advantage and in extensive use for calculating, for technical literature, for	a. It is not of greater advantage, nor in more extensive use than the English system for calculating, for technical literature,

Con	Pro
educational work, and so forth.	for educational work, and so forth.
b. It is superior and predominantly used in scientific and related fields.	b. Although there are some advantages in using it in scientific and related fields, the absolute or centimeter-gram-second system is preferred. Furthermore, the use of some units of the metric system in scientific work does not prove the advisability of adopting it generally, because the scientific field is small, and its methods and products are not standardized.
c. It is applicable to and frequently used in engineering activities.	c. The English system is more applicable and more generally used in engineering activities, especially in Great Britain and the United States.1/
d. Its advantages and use in scientific fields warrant its compulsory use in agriculture, mining, and transportation because of: (1) Its intrinsic merits. (2) The increasingly close relation between scientific research and the development of these fields, which emphasizes the importance of using one system in all.	d. The metric has no advantages in agriculture, mining, and transportation, while the English system is thoroughly established in these fields; has been found adequate in fulfilling the needs; and serious confusion would result from a change.
e. Its advantages and use in some manufacturing warrant a change in this whole field.	e. The metric system has no special advantages to offer in general to manufacturing, which has been built up in English units. The English system is particularly applicable to most industrial processes. Many industries all over the world have been developed in this system. It is used in

1/"The United States consumes a larger proportion of the world's raw materials than any other country, probably as much as 40% of the total." Foreign Commerce Yearbook, 1938, Washington: Government Printing Office, 1939, p. 419.

Con | Pro

many metric countries in the manufacture of special products.

Con

f. It would be found to have advantages in domestic trade.

g. Its extensive use in the foreign trade of other countries would cause its adoption in the United States to foster the latter's foreign trade.

3. A compulsory change to the metric system in the United States would be practicable because:

a. The experience of other countries in suppressing customary units has shown that there would be no serious difficulties involved in such a change, and that the people would adopt the new units easily and without confusion after a short period of transition, if the compulsory law were applied and extended gradually.

Pro

f. The metric is not better adapted to domestic trade, since the English system is thoroughly established, and in daily use. A change would require the modification of the habits of the entire buying public. The experience of other countries has shown how difficult it is to effect such a modification.

g. A compulsory change to the metric system would not be advantageous to the foreign trade of the United States since:

(1) That trade is already well established and flourishing in the English system.

(2) At least half that trade now is with non-metric countries.

(3) The price of the article and the credit facilities are the determining factors, not the system of weights and measures.

3. A compulsory change to the metric system in the United States would be impracticable because:

a. The experience of other countries has shown that the change causes enormous disturbance to the everyday habits of the people; compels the use of two or more systems of weights and measures, creating untold confusion in industry and trade; and requires a long transition period. These difficulties would be even greater in the United States, regardless of the character of the compulsory legislation, because the English system is so thoroughly established here.

Con

b. It would require little altering or discarding of mechanical standards and equipment, and would involve largely only applying metric measurements to the units of our present standards, which would be preserved without change as long as desirable or advantageous.

Pro

b. The compulsory adoption of the metric system would require discarding the established system of standards and equipment, and interchangeable parts because:

(1) It is impossible to apply equivalent metric designations to the old standards.

(2) It is impossible to replace gradually with metric the old standards and equipment. Therefore there would be a protracted period of waste and confusion.

Con

c. The cost of the change has been tremendously overestimated. It would involve only the translation and revision of literature, and the replacing of present weights, measures, and scales. This would be more than compensated for by resulting savings.

Pro

c. The cost of the change would be enormous, involving not merely translation and revision of literature, but changes in material and equipment, plus the additional expense due to inefficiency, waste, and the carrying of a double stock of repair-parts over a long period of years. This tremendous cost would be passed along to the public in increased prices and overcharges.

Con

4. A compulsory change to the metric system would save much time in the school life of every child in the United States, thus effecting a saving of about $800,000,000 each year. Because metric units are interrelated logically, the system can be reduced to three main words: meter, liter, and gram. Thus it can be learned by any child overnight. In the lower grades of our schools, there should be compulsory instruction in the metric system.1/

1/United States Hearings, 1926, op. cit., pp. 5, 10, 22, 30, 35-36, 43-48, 57-58, 80, 110, 253, 258, 266, 278, 282, 298, 312, 324.

Pro

4. The compulsory use of the metric system would not decrease the time required for the study of weights and measures by children in the public schools, but would rather increase it, because a dual system would result.1/ Moreover, the National Committee on Arithmetic of the National Education Association of the United States (1926) recommended the complete elimination, from the curriculum of the public schools, of apothecaries' weight, Troy weight, and the metric system, since these "have interest and value only for those who fit

1/United States Hearings, 1926, op. cit., p. 201.

b. It would require little altering or discarding of mechanical standards and equipment, and would involve largely only applying metric measurements to the units of our present standards, which could be preserved without change as long as desirable or advantageous.

c. The cost of the change has been tremendously overestimated. It would involve only the translation and revision of literature, and the replacing of present weights, measures, and scales. This would be more than compensated for by resulting savings.

4. A compulsory change to the metric system would save much time in the school life of every child in the United States, thus effecting a saving of about $200,000,000 each year. Because metric units are interrelated logically, the system can be reduced to three main words: meter, liter, and gram. Thus it can be learned by any child overnight. In the lower grades of our schools, there should be compulsory instruction in the metric system.1/

1/United States Hearings, 1926, op. cit., pp. 5, 10, 22, 30, 33-36, 43-48, 57-58, 80, 110, 235, 255, 266, 279, 282, 295, 312, 324.

Con | Pro

themselves for special vocations.... the public at large does not use them. Apothecaries' weight is used by medical men and druggists; troy weight by those having to do with precious metals; the metric system by scientists, laboratory chemists; and such as find it convenient in their calling." This recommendation was based on the work of 300 school superintendents.1/

5. (Con) There is a strong and growing demand for the compulsory adoption of the metric system in the United States. This is evidenced by petitions to Congress, signed by thousands, representing varied interests such as: scientists, chemists, inventors, educators, engineers, manufacturers, exporters, and so forth.

5. (Pro) There is no demand for the compulsory adoption of the metric system in the United States, except the little which comes chiefly from scientists, teachers, and associations formed for the purpose of spreading metric propaganda. There is emphatic opposition from manufacturers, engineers, and those involved in other large and practical fields which would suffer most through a change.

6. (Con) Generally speaking the metric has a better chance than the English of becoming the universal system because:

   a. It is used more, by and large.

   b. Its advantages and use in some fields warrant its extension to all fields.

6. (Pro) The English has as good, if not a better chance, than the metric of becoming the universal system because:

   a. It is used extensively in world trade. In fact, the uniformity of usage of the English system is greater than that of the metric in every respect: population, work, area, and time.2/

   b. The advantages and use of the metric system in certain fields do not warrant its extension to other fields. On the contrary, the advantages and use of the English system in the larger and more important fields justify its retention in those fields and its use in all other fields.

1/*Ibid.*, pp. 201-203.

2/*Ibid.*, pp. 239-240.

Con	Pro
c. Sentiment in favor of the compulsory adoption of the metric system is increasing in Great Britain as well as in the United States.1/	c. Sentiment in favor of the compulsory adoption of the metric system is not increasing in Great Britain and the United States. This is evidenced by its insignificant use after having been permissive for 60 years. Furthermore, there is increasing indication that the English system, somewhat simplified and decimalized, is coming rapidly to be recognized as the ideal system, and destined to come ultimately into universal use.

In conclusion the writer would like to point out that the above list of studies is not exhaustive; it is, however, typical. There has been real controversy in the United States during the past few decades over the compulsory adoption of metric weights and measures as the sole standards and their compulsory use. Metric propaganda has been rife. It has been supported by the "intellectuals"; it has been opposed by manufacturers, business leaders, and engineering societies. Those who take the practical view seem likely to win in this country as in England, although the controversy is not over yet.

1/Ibid., p. 7.

CHAPTER IV

PREVIOUS INVESTIGATIONS PERTINENT TO THE PROBLEM

This chapter summarizes previous studies pertinent to the problem, and gives the conclusions of the investigators.

I. Halsey's Study

Twenty-three years ago, in 1919, Halsey investigated "the claims made for the metric system, and especially the claim that its adoption is necessary in the interest of export trade."

His answers to these claims are as follows:

1. Even in France old non-metric units are still used, because they are superior for the purposes of everyday life, and of manufacturing.1/

2. "What is now called the metric system is but a fragment of that system as devised and understood by its promoters."2/

3. It is not an easy and simple matter for a country to change its system of weights and measures, as the Latin American part of this study shows.3/

4. The adoption of the metric system does not do away with confusion in weights and measures, as the Latin American part of this study shows.

5. "In no country investigated is the [metric] system universal."4/

6. If the United States is to change its "weights and measures in order to conform to the practice of Spanish America," the Spanish, not the metric, system should be adopted.

7. The adoption of the metric system does not lead to an important saving of time in primary education, because "with a mixture of systems in use, children have more, not less, to learn."

1/Halsey, op. cit., p. 2.

2/Ibid., p. 1.

3/Ibid., p. 120.

4/Ibid., p. 77.

8. Experience with adults shows that learning to think in metric units, especially in metric compound units, requires considerable time.1/

9. The adoption of the metric system does not lead to a saving of time in calculating, because a mixture of systems in use, involves the constant necessity for conversions, which increase the labor of calculating.

   a. The elimination of the processes of reduction, ascending and descending, has eliminated the advantages of the decimal ratio.2/

10. The persistence of old units in metric countries is not merely the use of old names for new units, as the Latin American part of this study shows, because many of the "reports give values of the Spanish in terms of metric and English units."3/

11. Articles manufactured to a unit "are uniformly sold by the unit to which they are made."4/ Metric equivalents for customary sizes are not used. It is not merely a matter of a new term of expression.

12. Great Britain does not favor compulsory adoption of the metric system.5/

13. The metric system is not better than other systems because:

   a. France has retained only a part of the original system.6/

   b. In all Latin American countries, after more than a half century of trial, the metric system is used "in exact accordance with the severity of the laws, and in most of these countries among the people, it is used but little."7/

   c. Individual companies such as: The Ericsson Manufacturing Company of Buffalo, New York (manufacturers of the Berling magnets); the Solvay Process Company of Syracuse, New York (manufacturers of chemicals); the Library Bureau of Cambridge, Massachusetts and London, England; the Willans and Robinson Company, Rugby, England, which are engaged in industry in the United States and Great Britain, have repeatedly adopted the metric system, but have abandoned it later.8/

1/*Ibid.*, p. 97.

2/*Ibid.*, p. 126.

3/*Ibid.*, p. 78.

4/*Ibid.*, p. 79.

5/*Ibid.*, p. 80.

6/*Ibid.*, p. 83.

7/*Ibid.*, p. 85.

8/*Ibid.*, p. 86.

d. Manufacturing chemists do not use the metric system.1/

14. Our weights and measures would not be simplified by replacing the English system with the metric, because we would then have a dual system.2/

15. Manufacturers oppose the metric system because of the necessity of change from one set of sizes (English) to the other (metric), with resulting overwhelming cost.3/

16. Engineers oppose the metric system because:

    a. The technical literature (formulas, and so forth) would have to be rewritten.

    b. The technical tables would have to be recalculated.4/

17. The metric system is well adapted to scientific use, that is, laboratory experimentation.5/

18. The "metric equivalent" scheme is not feasible, because it involves too much calculating.6/ In general, metric and customary units are incommensurable.

19. Unification of the weights and measures of the two Americas and of the British Empire on the basis of the Roman system, which is common to all, would be a rational program because:7/

    a. The English system is used universally in navigation and sea measurements.

    b. The preponderance of the English system in manufacturing is overwhelming.

    c. The preponderance of the English system in international trade and commerce is overwhelming, "due to the fact that the United States and Great Britain are the chief manufacturing and trading nations."

    d. "The forces of trade and commerce have carried the English system to every quarter of the globe."

    e. "All the nations investigated use the English system, and are perfectly familiar with it."

1/Ibid., p. 87.

2/Ibid., p. 88.

3/Ibid., p. 100.

4/Ibid., p. 104

5/Ibid., p. 108.

6/Ibid., p. 111.

7/Ibid., p. 151.

f. "People everywhere do not like the metric system, and refuse to use it except to the extent to which they are compelled by law."

g. "The attempt to adopt the metric system has been followed by failure after failure," due to (f) above.

h. There is great similarity between the English and Spanish systems, "which are substantially identical in structure. Where they differ, it is chiefly in the values of units, and this difference, in the case of the most important units in international commerce--those of weight--is, for commercial purposes, negligible."

i. "In five countries of Latin America this slight difference in the values of units of weight (one-half of one per cent) has led to the general adoption of the English values."

j. "The German influence, which in the past has been largely responsible for the propaganda in favor of the metric" system, in future will be negligible.1/

To get an answer to the latter part of the problem, Halsey first sent out some 6,000 questionnaires 2/ to manufacturers in the United States. His conclusions, based on an analysis of the 1,445 questionnaires, 3/ which were returned, are as follows:

1. "That the commerce of the world is conducted by the English system."4/

2. In production, 82% of United States exporters to metric countries do not use the metric system at all; 14% use it partially; and 3/10 of 1% use it exclusively.

3. In commerce, 1.6% of United States exporters use the metric system in response to a commercial need; 38% make some use of it in shipments, because compelled to do so by the laws of foreign countries; and no exporter uses it exclusively.

1/Ibid., p. 150.

2/Ibid., p. 35.

3/Of these, 284 were from manufacturers engaged in export trade from ten to twenty years; 225 from manufacturers engaged in export trade from twenty to forty years; 48 from manufacturers engaged in export trade from forty to sixty years; and 10 from manufacturers engaged in export trade from sixty to one hundred years or more.

4/Ibid., p. 72.

Halsey next sent out about 500 questionnaires,[1] translated into Spanish and Portuguese, to South America, Central America, and the West Indies. These were distributed through correspondents and branches of the National City Bank, the United Fruit Company, W. R. Grace and Company, and the Hill Publishing Company, while he personally sent out additional copies to United States Consuls and to others, whose names he obtained from a commercial list compiled by the United Fruit Company. His conclusions, based on an analysis of the 116 questionnaires, which were returned from 16 countries, are as follows:

1. "The effort to learn the relative usage of the different systems has not been successful. When one return gives exclusive use of the metric system for a given purpose and another exclusive use of the Spanish system for the same purpose, discrimination is impossible."[2]

2. Uruguay is the only Latin American country investigated in which the metric system has been adopted for domestic trade, the compulsory law of 1894 providing that fines shall be imposed for the use of other systems,[3] and yet in spite of this, lumber and timber are usually measured per thousand feet; carpenters and other woodworkers generally use the English foot and inch; in machine shops "practically" the English inch is used; sizes of pipes for gas, water, sewers, and so forth, are "practically" in pulgadas (0.96 inch); marine measurements are "to a large extent the marine mile and in practice there is no effort to abolish completely the English measures."

3. "In other Latin American countries the adoption of the metric system is much less complete than in Uruguay," but the system is obligatory also in the following twelve countries: Argentina, Brazil, Bolivia, Chile, Colombia, Costa Rica, Cuba, Guatemala, Mexico, Nicaragua, Peru, and Spanish Honduras.

4. Except in the railways and in other fields under immediate government control, the metric system has made very little impression in the following ten countries: Colombia, Costa Rica, Cuba, Guatemala, Nicaragua, Spanish Honduras, Panama, Porto Rico, San Salvador, and Ecuador.

1/*Ibid.*, p. 4.

2/*Ibid.*, p. 6.

3/*Ibid.*, p. 74.

5. In six of these ten countries, the metric system is obligatory (see 3 above). In five: Colombia, Cuba, Spanish Honduras, Panama, and Porto Rico, "the English units are used far more than the metric, having largely supplanted all others, although in three: Colombia, Cuba, and Spanish Honduras, the metric system is obligatory. Not only has the English pound come into large use, but the arroba [25.35 pounds] and quintal [101.40 pounds] have been adjusted in value to make them equal to 25 and 100 English pounds, respectively. In substantially all of the countries investigated, the English inch is used for mechanical purposes; as the English nautical units are used for navigation and sea shipments. The nautical mile is used by all countries that sail the seas, while the kilometer is an unknown measure at sea."1/

6. "In all countries the impression made by the metric system is in direct relation to the severity of the laws, of which Uruguay is the climax with Venezuela and Argentina not far behind. In all cases the movement was begun with mild laws under the impression that the adoption of the system was a simple and easy thing to bring about. Such laws failing, more drastic ones followed, but even these have been but partially effective." The greatest progress has been made in domestic retail trade, since these weights and measures can be most easily inspected by officers of the law. The vara (0.91 yard) is commonly the measure of length for the sale of dry goods. Imported wearing apparel is usually sold by the units of the country from which it comes, while such domestic products are frequently made to local numbered sizes, which apparently are not related to any system of units.

7. In wholesale markets, the old measures are most common, "although these, in some cases, have been adjusted in value to make them even multiples of English basic units."

8. "Lumber and timber are almost universally sawn to the inch, although frequently mixed with the vara [0.91 yard] or the meter for length and the square and cubic meter as sales units, prices being made at so much per square or cubic meter for one-inch boards."2/

9. "Tailors and seamstresses use all three systems, as do stone and brick masons, while carpenters commonly use the pulgada [0.91 inch] or English inch. In machine shops both English and metric units are used," depending chiefly on the country from which the machines come, but the use of the inch predominates. Thus the Cleveland Twist Drill Company reported that their tools shipped to South

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1/*Ibid.*, p. 7.

2/*Ibid.*, p. 8.

American customers use more English than metric sizes.[1]

10. In ship and boat building, likewise, the English units are commonly used, while "in mining and smelting....a miscellaneous mixture of all three systems" (Spanish, English, and metric) is used.

11. The continued use of customary units "is most pronounced in the measurement of land....In Uruguay, where the laws are more severe and more rigidly enforced than in any of the Latin American countries, it has been found necessary to authorize the use of old land units, while in the other countries the laws in regard to land measurement are quietly ignored. This is the more significant because all transfers of real estate, as matters of public record, come before the eyes of officers of the law. In other countries the purchase and sale of land are made in Spanish units, the metric equivalents being inserted in documents of record."

12. "In marine measurements and sea shipments the English system is used everywhere, although mixed with metric units, especially for inland navigation."

13. "Classified in another way, the most-used metric units are those of capacity. Next come those of weight, and trailing far in the rear those of length and their correlatives of area."[2]

The general conclusion to which Halsey comes from the Latin American part of his study is that in the countries where the metric system has been adopted, confusion and disorder have resulted from the experiment in proportion to the strictness of the enforcement of the laws making its use compulsory.

1/Ibid., p. 14. The Boston Pressed Metal Company also reported that "standard English sizes are accepted and used in Argentina without question, and that there has never been any suggestion from their agent in Buenos Aires that metric sizes were required or preferred."

Ibid., p. 58. "A census of the machine tools used in the machine shops of South America showed that 39.3% of the machine tools are American, 43.2% are British, and the remaining 17.5% are German, Belgian, and French. Thus the ratio is nearly 5 to 1 in favor of the non-metric machine tools."

2/Ibid., p. 9.

II. Stutz's Report

In an article,[1] based on reports from United States Consuls in foreign countries and from foreign Consuls stationed in the United States, Stutz points out that these Consular reports (1919 and 1920) of the United States Department of Commerce officially confirm the findings in "The Metric Fallacy" by Halsey. Abstracts from some of these unpublished reports give the following information in regard to Argentina: the gallon is commonly used as a measure of capacity in the sale of mineral oils, naphtha, and paints; the bushel is used very commonly as a dry measure; the pie (0.95 foot) is used in wood transactions; the libra (1.01 pound) is used for the purchase and sale of tea; and the vara (0.95 yard) is used for transactions covering land in the federal capital and in suburban centers.

It is also reported both by the United States Consul in Rio de Janeiro and by the Brazilian Consul in the United States that: in the vast interior of Brazil many of the measures introduced by the early Portuguese settlers are still somewhat in use, especially the vara (1.21 yard); the garaffa (bottle) persists in both cities and in the country; in measuring land the old units are still in use; the English measures, particularly feet and inches, are commonly used in trades, where the machinery and materials are imported from England and the United States and therefore, in the textile industry, which is the most extensive manufacturing industry in Brazil, the widths of cloth are commonly given in inches; carpenters also frequently use the English foot and inch.

In Paraguay, it is reported that the law makes the metric system legal, and that it is in general use, but that some 19 non-metric units

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"are still used to some extent."

Colombia, Cuba, Nicaragua, Panama, Peru, and San Salvador are reported upon in a similar fashion. The arroba (25.35 pounds), the vara (0.91 yard), the libra (1.01 pound), as well as other Spanish weights and measures are generally used in all these countries. In Nicaragua and Panama the English units are also used extensively.

III. Dale's Study

At the First Pan-American Standardization Conference in Lima, Peru, December 23, 1924, Dale made a notable contribution [1] in this field. He points out first the momentous importance of such a conference, which is planning for an area extending "from pole to pole and from the Atlantic to the Pacific; sixteen million square miles; or nearly one-third of the land area of the globe. The purpose of the Conference is to guide and control standardization of all products, raw and manufactured, throughout the Western Hemisphere--forever."

He next calls attention to the fact that the English, Spanish, and closely allied Portuguese systems of weights and measures were brought to North and South America respectively by the colonists; the English system becoming "fundamental in the area included in Canada and the United States; and the Spanish, for nearly three hundred and fifty years, occupying "a like position as the accepted and undisturbed standard of Latin America," until the metric system was grafted on to it.

Dale then shows that the Spanish and English units are "but variations of one natural system, whose origin is lost in the obscurity that surrounds

1/Samuel S. Dale, Standardization for Pan-America, New York: The American Institute of Weights and Measures, Quarterly Bulletin (January), 1925, pp. 11-16. See also Primera Conferencia Panamericana para la Uniformidad de Especificaciones Actas y Demás Documentación, Lima: Moreno, 1927, pp. 457-462.

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pre-historic man." The standards, from which these units were derived, can be traced through the ages back to Rome, Greece, Egypt, Assyria, Babylonia, and India. The proof of this is that "the divisions of length and weight are exactly the same (12 inches in 1 foot; 3 feet in 1 yard; 16 drams in 1 ounce; 16 ounces in 1 pound; and 2000 pounds in 1 ton); while the sizes of the units of weight vary only 1.4% and the linear units only about 10%," as the following table[1/] makes clear:

Table 2. A Comparison of Spanish and English Weights and Measures, Showing that the Units of Weight Vary Approximately 1.4% and the Linear Units Approximately 10%.

	Spanish Libra	English Pound
Spanish libra	1.000	1.014
English pound	0.986	1.000
Spanish arroba	25.000	25.350
Spanish quintal	100.000	101.400
English hundredweight	110.430	112.000
Spanish tonelada	2000.000	2028.000
English long ton	2208.640	2240.000
English short ton	1972.000	2000.000
	Vara	Yard
Spanish vara	1.000	0.914
English yard	1.094	1.000

Dale finally summarizes the comparative use of the English and Spanish-metric systems, showing how much greater use is made of the English.[2/]

1/Samuel S. Dale, Uniformity or Confusion in Pan-America? New York: The American Institute of Weights and Measures, Quarterly Bulletin (July), 1925, p. 5.

2/Ibid., p. 14.

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English Pound	Spanish Libra	
1.014	1.000	Spanish libra ....
1.000	0.986	English pound ....
25.350	25.000	Spanish arroba ....
101.400	100.000	Spanish quintal ....
112.000	110.430	English hundredweight ....
2028.000	2000.000	Spanish tonelada ....
2240.000	2208.540	English long ton ....
2000.000	1972.000	English short ton ....
Yard	**Vara**	
0.914	1.000	Spanish vara ....
1.000	1.094	English yard ....

Dale finally summarizes the comparative use of the English and Spanish-metric systems, showing how much greater use is made of the English.[2]

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[2] Ibid., p. 14.

Table 3. A Summary of the Comparative Use of the English and Spanish-metric Systems of Weights and Measures in Latin America, Showing that the English System Is Used to a Much Greater Extent.

	English	%	Spanish-metric	%
Area (square miles)	7,643,437	48.3	8,181,227	51.7*
Population	119,022,853	57.4	88,320,180	42.6
Government Revenue	$3,516,812,285	77.5	$1,019,744,403	22.5
Imports	$2,869,473,230	58.8	$2,005,683,667	41.2
Exports	$4,197,621,679	63.8	$2,376,597,925	36.2
Water Power (developed H.P.)	11,744,300	93.2	861,000	6.8
Railroads (miles)	303,620	80.7	72,511	19.3
Telegraph (miles of wire) .	2,108,341	81.2	486,541	18.8
Telephones (number)	15,301,795	97.1	449,080	2.9
(miles of wire)	39,676,482	97.2	1,137,507	2.8
Wool (pounds)	284,849,416	37.8	468,690,000	62.2*
Cotton (500 pound bales) ..	11,299,397	94.7	633,710	5.3
Copper (pounds)	987,371,643	69.5	433,126,878	30.5
Coal (2,000 pound tons) ...	528,375,022	99.4	3,094,843	0.6
Manufactures (employees) ..	11,535,599			
(value of products) .	$66,702,916,725			
(capital)	$48,107,811,506		Figures not	
(wages and salaries)	$14,270,493,174		obtainable	
(raw materials)	$39,727,725,386			
(installed H.P.)	34,429,470			

As will be seen from Table 3 the Spanish-metric system outranks the English only in the two items (starred): area and wool.

In conclusion Dale emphasizes the misrepresentation at previous International American Conferences, which has led Latin Americans to believe that most North Americans favor the compulsory use of the metric system. On the contrary "the people of the United States are overwhelmingly opposed to it," he maintains.

IV. Kennelly's Study

A study of non-metric weights and measures still in use in Europe was made some fifteen years ago by Kennelly. His findings were published in "Vestiges of Premetric Weights and Measures Persisting in Metric-System Europe 1926-1927." In the introduction to his report Kennelly states that he "has endeavored to lift the research out of the controversial plane, and into the region of statistical enquiry."[1] His problem is "research into the extent to which primitive units of weights and measures may persist in the European countries, which have adopted the metric system."[2] He visited the following nine countries: France, Switzerland, Germany, Belgium, Holland, Spain (including Majorca), Italy (including Sicily and Sardinia), Austria, and Czechoslovakia during the period July 1926, to September 1927. Of the scope of his study he says, "In this report, consideration is given mainly to commercial residual units. Industrial residual units have received only minor attention."[3] He further delimits the problem as covering principally the units of length, area (especially land), volume, and weight. Coins are not specifically included. The report gives the personal opinions arrived at by Kennelly plus written statements from some sixty officials in the countries visited.

The method of procedure used was to visit first the American Consul; explain the nature of the investigation; and request suggestions as to what persons, firms, or institutions would give the required information. In large cities and towns he visited offices for the checking of weights and

1/Kennelly, op. cit., p. vii.

2/Ibid., p. 1.

3/Ibid., p. 3.

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measures, surveyors, chambers of commerce, banks, land agents, and wholesale dealers. In smaller villages he made inquiries of the mayor, or chief magistrate. Verbal recollections he made note of immediately, and requested a brief written statement of the official's views. He also made inquiries, whenever possible, of store-keepers, hotel-keepers, bank clerks, fellow passengers in railway trains, and of casual acquaintances. He tried to ascertain at once to what extent residual non-metric units were used: rarely, commonly, in name only, or actually. Residual units he divided into three classes, and defined thus:

1. Metricised units--old unit names (originally belonging to a primitive system), which have been modified to designate some simple value, involving only one significant digit in the metric system, as for example, the German "Pfund"1/ (500 grams).

2. Submetricised units--old unit values (persisting from a primitive system), which are always bought and sold with metric-system apparatus, and involving more than one significant digit, as for example, the Netherlands "Elle" (0.6878 meter).

3. Non-metric units--old unit values (persisting from a primitive system), which are still bought and sold with primitive system apparatus, as for example, the "rheinischer Zoll" (1.03 inch).2/

The following are Kennelly's conclusions:

1. There is overwhelmingly general use of the metric system for internal commerce and the affairs of everyday life throughout the countries investigated in continental Europe.

2. Vestiges of pre-existing systems in all metric countries are rare in France and Germany; less rare in certain countries like Holland; relatively common in Spain and Italy.

3. Metricised units are the commonest vestiges in all countries.

4. Submetricised units are the next commonest vestiges, but are tending either to disappear or to become metricised at some round, simple value in the metric system.

1/The customary Pfund is 467.7 grams.

2/*Ibid.*, p. 7.

measures, surveyors, chambers of commerce, banks, land agents, and wholesale dealers. In smaller villages he made inquiries of the mayor, or chief magistrate. Verbal recollections he made note of immediately, and requested a brief written statement of the official's views. He also made inquiries, whenever possible, of store-keepers, hotel-keepers, bank clerks, fellow passengers in railway trains, and of casual acquaintances. He tried to ascertain at once to what extent residual non-metric units were used: rarely, commonly, in name only, or actually. Residual units he divided into three classes, and defined thus:

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1/The customary Pfund is 467.7 grams.

2/Ibid., p. 7.

5. Non-metric units are the rarest vestiges. Two only were found; the Rhineland inch, used by the carpentering trades in Germany, and the Balearic ounce, used by the silversmiths in Majorca. Both are said to be dropping out of use.

6. Non-metric vestiges are likely to disappear at a relatively early date; some submetricised old units are likely to continue for a considerable period; a number of metricised units are likely to continue indefinitely as local names for convenient metric quantities.

7. Vestiges of primitive units tend to persist longer in villages and on farms than in cities and towns; and they tend to persist in land areas long after they have disappeared in other fields of utility.

8. Elementary arithmetic books in the schools are a good indication of the number of vestiges of old measures retained in the commercial life of a country, or province. Local vestigial units are likely to be few if the books contain no comparative tables of old units with relation to the standard units of the metric system.

9. Vestigial units also occur in metric countries in their external trade relations with other countries, which have not adopted the metric system, but these units were not especially investigated in this report.

10. Vestigial units also occur in the manufacturing establishments of a metric country, but, as these units require special research in each particular industry, they were not especially investigated in this report.

11. In substantially all cases in internal commerce, the recorded quantitative communications among educated people are made in the metric system. Vestigial premetric units were found in the verbal, unrecorded statements of country folk, where the quantities mentioned became doubtful, indefinite, and ambiguous.

12. Extra vestigial units have resulted from a local and national intermediate decimal system, which was later abandoned in favor of the straight international metric system.1/

For a critical examination of Kennelly's conclusions see pages 96 to 123.

V. Wilson's Study

About ten years ago Wilson made a study of weights and measures in

1/Ibid., pp. 177-179.

Europe, collecting data in Belgium, France, and Germany. He found that non-metric units were being used, in spite of compulsory metric laws, often strictly enforced with severe penalties. In a significant article, "Why Non-Metric Measures in Metric Europe?" published in the February issue of "Education," 1932, he answers the following three questions:

1. Why the failure of the metric system?
2. Why the persistence of the customary units?
3. Why do we hear so much about the metric system?

His answer to the first of these is that the metric system has failed because it has neither theoretical nor actual advantages over customary weights and measures, and, moreover, it has some disadvantages. Dealing with the claims of the metric theorists, Wilson states that:

1. The "unit in nature" claim had to be abandoned officially by the French Government in 1869, when later measurements proved that a mistake had been made, and that the mètre was not one ten-millionth of the meridian quadrant.

2. The claim of interrelationship of tables (length, weight, and capacity) "has theoretical advantages only except in the chemical laboratory,--and no practical value in trade usage."

3. "Decimalization is no more common in using metric units than it is when customary units are used." Note the common use of binary fractions of metric units.

Actual trade usage "does not show any practical advantages of metric over customary units either, and there are some disadvantages," such as: no convenient foot, gallon, or bushel. Wilson summarizes thus:

1. "Any metric unit, which has been readily accepted, is a close approximation to a customary unit.

2. "Metric units, which do not closely approximate customary units, have been accepted slowly and unwillingly, if at all.

3. "Metric units are halved and quartered exactly as are customary units. Decimalization is used in statistics and refined

> measurement, but is not more used with metric units than with customary units."1/

His answer to the second question is that "customary units are the result of centuries of natural selection and adaptation to the work at hand." They have survived and persist, because "they are more convenient and better suited to trade conditions." The manufacturing and trade of the world are still largely non-metric.

Organized metric propaganda is Wilson's answer to the third question, because by this means the French intellectuals "hope to conquer the world for the metric scheme"2/ and "the glory of France."

In Chapter VI of this dissertation the data from the studies by Halsey and Kennelly will be analyzed and interpreted.

1/Guy M. Wilson, "Why Non-Metric Measures in Metric Europe?" Education, LII (February, 1932), p. 323.

2/Ibid., p. 324.

CHAPTER V

THE STUDY PROCEDURE

This investigation consists of three parts. Part I is preliminary background research, including the history of weights and measures and a survey of the literature in the field of the problem. Part II is a study of previous investigations pertinent to the problem, including tabulation, analysis, and interpretation of the data available from two of these studies. Part III, a field study, pursued in four South American countries (Brazil, Paraguay, Argentina, and Uruguay) supplements Part II.

Part I. The Preliminary Background Research

The preliminary study, which was begun in 1938, consisted of library research, interviews, correspondence, and visits to machine shops and museums. The library research was carried on chiefly in the Boston University Library, the Boston Public Library, and the Dale Collection of the Columbia University Library in New York City. Books and periodicals in English, French, German, Spanish, and Portuguese (Brazilian) were consulted. The Brazilian, Argentine, Paraguayan, and Uruguayan Consuls in Boston and New York were interviewed to obtain additional information and material. Likewise officials and agents of United States firms, doing business in South America, were interviewed. By correspondence, agencies familiar with conditions in South America were contacted, such as the Pan American Union, Washington, D. C. and the American Red Cross, Washington, D. C. Letters were written also to the Consulado General Del Paraguay,

New York; the Consulado De La República Argentina in both New York and Boston; the American Consulate General, Rio de Janeiro, Brazil; the American Consulate General in Buenos Aires, Argentina; the Argentine-American Chamber of Commerce, New York; the National Bureau of Standards, Department of Commerce, Washington, D. C.; the United States Government Printing Office, Washington, D. C.; the United States Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C.; the United States Department of the Interior, Geological Survey, Madison, Wisconsin; the American Institute of Weights and Measures, New York; the World Federation of Education Associations, Washington, D. C.; and the National Education Association, Washington, D. C. Individuals, with whom the writer had correspondence in pursuing this background study, included Dr. Walter R. Ingalls, President of the American Institute of Weights and Measures, New York; Dr. Gustavo Lessa of Rio de Janeiro, Brazil; Mr. E. W. Childs of the Brown and Sharpe Manufacturing Company, Providence, Rhode Island; and Mr. Sabin St. Germain in New York, agent for the Brown and Sharpe Manufacturing Company.

Visits were made to the Art Museums in Boston and New York for the purpose of checking information in regard to ancient weights and measures. The writer also visited the laboratory and shops of the Brown and Sharpe Manufacturing Company in Providence, Rhode Island; the machine shops of the Norton Company in Worcester, Massachusetts; and the Pratt and Whitney machine shops in Hartford, Connecticut, distinctive companies having world-wide connections, for the purpose of studying in actual use the latest precision instruments for weighing and measuring. In all three of these companies officials were interviewed.

Much of this preliminary research was done in order to give the

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Much of this preliminary research was done in order to give the

investigator sufficient background for understanding the field work involved in the primary study. The metrological background, as developed from the history of measures and weights, is presented in Chapter II.

Part II. The Study of Previous Investigations

A thorough survey of the literature in this field showed that only five investigations pertinent to the problem have been made. The literature of the immediate field, and a general review of previous investigations are presented in Chapters III and IV respectively. Two of the investigators, Halsey and Kennelly, have published their findings in enough detail, so that it was possible for the writer to tabulate these in a manner similar to that used in the treatment of the data obtained in the writer's own field study, making comparisons possible. In Chapter VI these findings will be analyzed, and interpreted.

Part III. The Field Study

The field work in South America was done by the writer in Brazil, Argentina, Paraguay, and Uruguay during the summer of 1939 (June to October) for the purpose of making a study of the problem on a numerical basis. In preparation for this part of the study the following statements and questions were formulated; translated into both Portuguese and Spanish; and written on three sets of cards (8 x 5), which could be used in case it were impossible otherwise to make the person being interviewed or observed understand. The statements and questions were:

Card I

I am a student at Boston University, U. S. A.

I am making a study of all the weights and measures, which are being used in South America.

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Card I

I am a student at Boston University, U. S. A.

I am making a study of all the weights and measures, which are being used in South America.

Card II

Do you use weights and measures in your business?

What weights and measures do you use? May I see them, please?

Do you ever use any weights and measures, which are not metric?

Do you ever use any Spanish, (Portuguese), or English weights and measures?

Do you ever use any of the old weights and measures?

Thank you very much.

Card III

I shall be very grateful if you will permit me to observe for a little while what measures and weights you are using. Thank you very much.

It so happened that the investigator never had to make use of these cards, but they might well have been invaluable in case of misunderstanding on the part of any official. Brazil was already seething with political unrest, and the European war began at the end of the summer. The investigator carried also some letters of introduction, which were likewise unnecessary precautions.

The field study actually began as soon as the investigator boarded the S. S. Boniface, a British freighter, bound for Belém, Pará, the Brazilian port at the mouth of the Amazon River. Information in regard to the ship's cargo was obtained from members of the crew, while the ship was being loaded at Staten Island, and later the Second Officer gave quite complete information from his records in regard to the usual cargo both to and from South America.

Another fruitful source of information was interviewing fellow passengers, exporters who bought extensively in the interior, and business men, who knew the customs of the people. Through the kindness of one of the

latter the investigator had the opportunity of visiting an insecticide factory in Belém, Brazil. On the two native river boats also much information was obtained in this same manner from a traveling salesman, a Japanese Consul, a South African business man, and North American and Argentine ladies.

As soon as the investigator arrived in a new place, it was found expedient to call on the American Consul and present a calling card, which introduced the investigator as a research student at Boston University, U. S. A. The nature of the investigation was then explained, and suggestions were requested as to what places might be visited. The following limitations were set:

1. That the business be one of the largest in that vicinity.
2. That the business be native owned.
3. That there be someone there, who spoke English well. (If this were not possible, the investigator secured an interpreter.)

Without exception the Consular Service extended every courtesy, and gave unfailing help and encouragement. Often the Consul, or in the larger cities, the Commercial Attaché, contributed much valuable information, or had a secretary obtain it directly.

When it was necessary to use an interpreter the investigator tried to give that person as clear a picture as possible of the problem, and of the data desired, which were the following:

1. The address of the business, and the name and position of the person interviewed.
2. The relative importance of the business, and the number of employees.
3. The specific weights and measures used in the various departments

of the business, such as:

a. Buying raw materials.

Where these materials came from.

b. Importing.

The products and the countries from which they came.

c. Manufacturing.

The kind of machinery used, and where it was bought.

d. Selling.

e. Exporting.

Whenever possible the investigator visited the factory or shop, and observed the actual measuring and weighing, but sometimes an office interview with the person in charge was sufficient, or all that could be arranged. In visiting municipal markets (wholesale and retail) it was sometimes necessary to be there at dawn in order to see the natives, who brought in their wares from the interior to sell. Likewise it was imperative to have an interpreter, who could understand and speak the dialects, which these people used, and who could also explain exactly why the investigator wanted the information, for, unless confidence was immediately established, the market people were afraid even to mention any weights and measures except metric on account of the penalties of fines and imprisonment [1] which they might incur by so doing.

Everywhere the investigator visited stores, large and small, to observe placards which indicated how goods were sold, and to watch the actual selling. Street vendors also were observed. Native guides often gave much information. A school was visited at Santarém, on the Amazon River, to see

[1] See Appendix D, pp. 265-280, for the penalties.

what weights and measures were being taught, and a public school inspector in Buenos Aires was interviewed.

Museums were visited in all of the larger cities in the hope of seeing some collections of weights and measures, but nowhere did the investigator find any, either customary or metric.

The investigator recorded the weights and measures observed in actual use or mentioned. Every effort was made to get representative and unbiased samplings. As has been mentioned above, the largest native-owned businesses were visited. As complete coverage as possible was ascertained of all the weights and measures used in the various departments, as, for instance, those used in the buying and importing of raw materials; in the manufacturing, including the machinery used; in the selling; and in the exporting. An official of the firm was always interviewed because he would have a general knowledge of the units used in all the branches of his business. The investigator visited a number of markets, as the detailed summary which follows (see pages 75-78) indicates. In every instance a thorough survey of the whole market was made, the usage being noted by commodities. The magnigraphs in Chapter VII (see pages 125-135) give this data in detail. A number of shops also were visited, and here, likewise, the investigator made as complete a survey as possible, in each instance checking with the manager to make sure that all the items had been covered. The aim was a coverage as complete as time permitted, and in the absence of complete coverage, a random sampling of typical industries. The places visited together with the other contacts, which were made totaled 104: 61 in Brazil; 21 in Argentina; 12 in Uruguay; and 10 in Paraguay. As will be

seen from the detailed summary, which follows, the interior as well as the coastal sections of these four east-coast countries was visited. The cities are along the coast, with the exceptions of Manáos, the Brazilian rubber-boom city which was built a thousand miles up the Amazon River on a spot carved out of the jungle; and Asunción, the Paraguayan capital which, likewise, is a thousand miles up the Paraná River. In this summary a further classification is made with reference to geographical location in Brazil (northern, central, and southern regions) because this one country is larger in area than the whole of the United States exclusive of Alaska. The places of business visited ranged in size from huge municipal markets (wholesale and retail), the largest industrial plants, and immense department stores, to vendors on the street. The range of products investigated, likewise, was extensive, including insecticides, hides and skins, textiles, food, glass, shoes, jewels, and so forth. The contacts made ran the gamut of society: owners and managers of the largest mills, factories, and commercial concerns; exporters and importers; business men; keepers of large and small shops; traveling salesmen; street vendors; Consuls and Commercial Attachés; college and university directors; teachers; ships' officers; fellow travelers; guides; a chemist; a tailor; a jeweler; a lawyer; a public school inspector; and so forth.

A detailed summary of the places visited and the contacts made by the investigator is as follows:

Brazil

(Northern Coast)

Visited	Interviewed
Insecticide factory, Belém, Pará.	Second Officer on S. S. Boniface, Fortaleza, Ceará.
Open-air market, Belém, Pará.	Exporter of hides, skins, and furs on S. S. Boniface, Belém, Pará, Maranhão, and the interior.
Shops, Belém, Pará.	Exporter of cocoa, São Salvador, Bahia, and the interior.
Commercial museum, Belém, Pará.	Two travelers, Fortaleza, Ceará, and Maceió, Alagôas.
Novelty shop, Belém, Pará.	Chemist, insecticide factory, Belém, Pará.

(Central Coast)

Visited	Interviewed
Textile mill, São Salvador, Bahia.	United States Consul, São Salvador, Bahia.
Woodworking factory, São Salvador, Bahia.	

Examined newspaper, Recife, Pernambuco.

(Southern Coast)

Visited	Interviewed
Store (5¢ to $1.00), Rio de Janeiro.	Secretary at United States Consulate, Rio de Janeiro.
Fruit store, Rio de Janeiro.	Manager at Industrial Charity School factory, São Paulo.
Men's furnishing store, Rio de Janeiro.	Teacher at Industrial Charity School factory, São Paulo.
Cotton mill, Rio de Janeiro.	

Visited	Interviewed
Wharves, Rio de Janeiro.	Guide, São Paulo.
Tailor, Rio de Janeiro.	Secretary at United States Consulate, São Paulo.
Industrial Charity School factory, São Paulo.	United States Consul, Santos.
Municipal market, São Paulo.	
Department store, São Paulo.	
Fruit store, São Paulo.	
Small shops, São Paulo.	
Store (5¢ to $1.00), São Paulo.	
Fruit and grocery store, São Paulo.	
Silk factory, São Paulo.	
Store, selling iron and building materials, São Paulo.	
Market, Santos.	
Small shops, Santos.	
Coffee Exchange, Santos.	

Observed street vendor, Rio de Janeiro.

Examined newspaper, São Paulo.

Observed street flower stall, São Paulo.

(Interior)

Bon Jardim, Pará.	Traveling salesman, and others on S. S. Belém, Amazon River.
Floresta, Pará.	Exporter of tropical fish on S. S. Belém, Amazon River.
Market, Santarém, Pará.	Japanese Consul on S. S. Belém, Amazon River.
Stores, Santarém, Pará.	Guide, Manáos, Amazonas.
School, Santarém, Pará.	
Parintins (Japanese colony), Amazonas.	

Visited	Interviewed
Villa São Carlos, Amazonas.	
Municipal market, Manáos, Amazonas.	
Department store, Manáos, Amazonas.	
Deposito ze Florence, Amazonas.	
Vallinhos.	
Coffee farm, Campinas.	
Silk factory, Campinas.	

Examined newspaper, Manáos, Amazonas.

Paraguay[1]

Cotton exporter, Asunción.	Lawyer, Asunción.
Market, Asunción.	Director of University, Asunción.
Maté company, Asunción.	Secretary at United States Consulate, Asunción.
Tobacco company, Asunción.	Director of International College, Asunción.
	Business man on S. S. General Alvear, Paraná River, Asunción and the interior.

Examined transfer of property, Asunción.

Argentina (Northern Coast)

Municipal market, Buenos Aires.	Commercial Attaché at United States Consulate, Buenos Aires.
Small shops, Buenos Aires.	Traveler on S. S. General Alvear, La Plata River.
Confectionery and bakery shop, Buenos Aires.	Public school inspector, Buenos Aires.
Stationery shop, Buenos Aires.	

1/The whole country of Paraguay is in the interior--a thousand miles or more up the La Plata and Paraná Rivers.

Visited	Interviewed
Glass factory, Buenos Aires.	
Biscuit factory, Buenos Aires.	
Chocolate factory, Buenos Aires.	
Textile factory, Buenos Aires.	
Biological Institute (wholesale and retail drugs), Buenos Aires.	
Bakery shop, Buenos Aires.	
Department store, Buenos Aires.	
Electric company, Buenos Aires.	
Shoe factory, Buenos Aires.	
Machinery manufacturers, Buenos Aires.	
Grocery store, Buenos Aires.	

Examined two newspapers, Buenos Aires.

Received letter from Dr. F. G. Weiss, Buenos Aires.

Uruguay (Coast)

Visited	Interviewed
Novelty shop, Montevideo.	Secretary at United States Consulate, Montevideo.
Meat packing company, Montevideo.	
Government industrial company, Montevideo.	
Importers, Montevideo.	
Jeweler, Montevideo.	
Shoe factory, Montevideo.	
Municipal market, Montevideo.	
General importers, Montevideo.	
Textile company, Montevideo.	
Department store, Montevideo.	
Wine store, Montevideo.	

The data of this field study will be presented, analyzed, and interpreted in Chapter VII.

Such a field study necessarily involved some difficulties. A basic and ever-present one was the compulsory use of metric weights and measures, government enforced by means of fines and imprisonment, or both. This was a powerful deterrent to the mention even of any except metric units, and necessitated spending considerable time in establishing and maintaining confidence and rapport. For this reason, among others, the investigator called on the United States Consul whenever possible, thus settling the question of identity and purpose immediately. A native interpreter, usually from the Consulate, also proved invaluable in dealing with this difficulty, as he had the prestige of being connected with the United States Consular Service, and at the same time had the confidence of his own people.

Such an interpreter likewise solved another difficulty--that of dialects. Only educated South Americans, the number of which is comparatively small, speak Spanish and Brazilian, the latter being a hybrid language (mixed Portuguese and Spanish). Particularly in the interior and among the less educated working class, which includes the great majority of the people in all the countries visited, dialects based on the ancient Indian languages, prevail. In a vast country, such as Brazil, the people living in the east-coast cities cannot understand the cabôclos (half-breeds) of the interior. The language also varies from north to south. As may be seen from any printed Brazilian, the language is still in a state of confusion. Even the spelling is not yet settled. In a city of the interior, such as Asunción, Paraguay, a university professor explained, the people cannot understand the Indian dialects of the more distant interior.

A third difficulty was due to the Latin American temperament and customs. Every call is a ceremony, and requires a very definite technique, often involved and always time-consuming, but nevertheless absolutely necessary. Like the Oriental, the South American may not be hurried. The investigator always presented a calling card,[1] which bore the magic work "University" on it. This assured prestige, without which one gets nowhere in Latin America. After the opening courtesies had been exchanged, there followed a leisurely conversation about anything except business. Finally, if all had progressed satisfactorily, which meant to a great extent that the investigator had not exhibited the slightest annoyance at what often seemed like endless delay, and didn't appear to be in a hurry, the psychological moment arrived to talk business. Once confidence and rapport have been established, the South American is not only extremely courteous but genuinely friendly, and will do everything in his power to be of service. From the above it may be understood why two or at most three visits in one day were all that could be managed.

Another difficulty to be reckoned with was one due to the general lack of sanitation and consequent health dangers. Although the investigator visited the interior during the best season of the year, the winter, still such dangers are always present in the tropics. Water (except bottled), and all uncooked foods were absolutely taboo, even though one had been inoculated for typhoid, para-typhoid A and B, and smallpox. But most to be feared were mosquitoes, which might be carriers of malaria or, worse yet, of yellow fever, and the bites of even the least harmful might be the beginning of a serious

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1/In this connection the following quotation from The Brazil Yearbook and Manual for 1940, p. 276, is interesting, "Commercial travellers in Brazil should be provided with handsome business cards, printed (or engraved) on high quality stock. Brazilians are strong on dignity; to them a fine-looking card indicates reliability and solidity."

infection. Flit and alcohol are worth their weight in gold in this part of the world. Eternal vigilance was the price of continued good health.

A fifth difficulty was the relentless march of war and its certain advent in the near future, which made Nazi-controlled Brazil and British-controlled Argentina alike equally suspicious of foreigners. The investigator made it an absolute rule, never to be violated on any occasion or for any reason whatever, not to discuss international politics or personalities. Extreme care was taken to avoid arousing the slightest suspicion. One misstep in this matter would have ended instantly the possibility of continuing the study. The investigator wrote no letters, and on the post cards sent back to the United States wrote only about the trivialities of sight-seeing. The gravity of the international situation was clearly demonstrated by the outbreak of war in Europe on September first. During the whole summer South America was seething with political unrest and European intrigue.

From the above presentation the reader will keep in mind when he comes to Chapter VII that the field study is based on 104 places visited and contacts made, 31 of which were in the interior and 73 on the coast, and that 18 were in rural districts and 86 in cities.

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From the above presentation the reader will keep in mind when he comes to Chapter VII that the field study is based on 106 places visited and contacts made, 31 of which were in the interior and 75 on the coast, and that 18 were in rural districts and 88 in cities.

CHAPTER VI

AN ANALYSIS AND INTERPRETATION OF THE HALSEY AND KENNELLY DATA

As has been indicated in the preceding chapter the investigator, for the purpose of comparison tabulated three different sets of data: Halsey's, Kennelly's, and her own gathered in the South American field study.

Treatment of the Data

The data, which the investigator gathered in South America, were tabulated on large master-sheets (18 x 24 inches), each of which carried one of four headings: Weight, Length, Capacity, or Surface. These sheets were ruled vertically, so that they had six columns headed as follows: Date, Place, State, Country, Metric, Customary. Such a tabulation made it possible to count the weights and measures observed actually in use or reported during interviews as being used. Due to lack of time it was necessary to estimate to some extent the metric usage. This was done in the following manner. In observing a large store-window display the writer found it practical to count the placards advertising customary units, and then estimate the number advertising metric units, as these were, of course, considerably more numerous. Usually a photograph of the display was taken, so that later this estimate could be checked from the picture.

Halsey's data gathered from questionnaire replies returned from Brazil, Argentina, and Uruguay, and Kennelly's data gathered in continental Europe were treated in the same manner. Kennelly's data, however, under the heading "Customary" were further subdivided, according to his own classification (see

page 63), into three columns which were headed: Metricised, Submetricised, and Non-metric. From these tabulations it was possible to figure the metric and customary usage on a percentage basis, and to compare the findings of the three investigations.

Halsey's Data for Brazil, Argentina, and Uruguay

The first step in analyzing Halsey's data was to summarize in table form the 52 questionnaire replies from the three countries: Brazil, Argentina, and Uruguay. Column I at the left gives the items for which both customary and metric weights and measures were used. Columns II and III give the items for which customary and metric units respectively were used exclusively, while column IV gives the comments made by those who answered the questionnaires.

Notwithstanding Halsey's conclusion that, "The effort to learn the relative usage of the different systems has not been successful," the following three tables certainly indicate the relative extent of customary and metric usage. The fact, which is most strikingly brought out, is the considerable extent to which customary units are used in these countries in spite of laws which prescribe severe penalties for the use of any weights and measures except metric. The number of items in columns III (Metric Exclusively) increases in accordance with the strictness of enforcement, Uruguay compelling metric usage by means of stricter inspection and severer penalties than either of the other two countries as is indicated by comment 10 in column IV of Table 6. A brief study of the comments, in general, makes clear the fact that a mixed system of weights and measures (Spanish or Portuguese, English, and metric) has resulted from the compulsory metric laws.

Table 4. A Summary of Thirty-seven Questionnaire Replies Received by Halsey from Brazil (1919),[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. groceries 2. fruits 3. butter and cheese (retail and wholesale) 4. other farm products 5. hardware (see comment 3) 6. meat (retail and wholesale) 7. flour 8. tea 9. dry goods 10. fuel (wood) 11. tobacco 12. hats 13. hosiery 14. shoes 15. gloves 16. land (see comment 4) 17. lumber and timber (see comment 5) 18. carpenters and other woodworkers (see comment 5) 19. stone and brick masons 20. machine shops (see comment 6) 21. contracts for excavation of ground 22. mines and mining products 23. smelting and smelter products	1. fine tobacco 2. marine--harbor charts, distance, drafts, tonnage (see comment 9) 3. railway equipment (units used in the construction and repairing of locomotives, coaches, and so forth)--measure	1. milk (retail and wholesale) 2. fish 3. coffee (retail) 4. fuel (coal and oil) 5. ready-made clothing 6. collars 7. underwear 8. corsets 9. tailors and seamstresses 10. sizes of pipe for gas, water, sewers, and so forth--length metal tubing for gas and water (see comment 7) 11. marine--freight (see comment 9) 12. garden products (wholesale) 13. railway tariff for passengers and freight (load and distance) 14. railway	1. Metric system adopted in 1863--obligatory in 1889. 2. "The official system of weights and measures is the metric; however the old Brazilian system is still commonly used." 3. Hardware: "Use all measures." 4. "For agricultural lands or open lands in general the division is almost universally into alqueires [11.96 acres]." "The standard throughout the state is the alqueire." "The old Brazilian legua [4.09 miles] is generally used." 5. "The thickness of lumber is always in English inches. Width in English inch by the lumber company and Portuguese inch by others. The lengths in feet by the lumber company and Portuguese inches by others." 6. In machine shops: "The metric system was established by

1/Halsey, op. cit., p. 14.

Table 4. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
24. sizes of pipe--gas, water, sewer, and so forth (see comment 7) 25. ship and boat building (see comment 8) 26. marine (see comment 9) 27. hay (wholesale) 28. grain (wholesale) 29. root crops (wholesale) 30. coffee (wholesale) 31. rubber (wholesale) 32. loads and rates (city transportation) 33. loads and rates (transportation by muleback across mountains) 34. railway equipment (units used in construction and repairing of locomotives, coaches, and so forth)		track gages and length of lines 15. railway equipment (units used in the construction and repairing of locomotives, coaches, and so forth)--weight	law under the Empire, as the only official system. The English system for metal work, is very popular." 7. "English system chiefly: metric system infrequently." "For the measurement of earthen pipes, the internal diameter is usually given in inches. Metal tubing for gas and water is measured by weight, per kilogram. Diameters are usually measured in inches and lengths in meters." "The English measures prevail for sizes of pipe--gas, water, sewer, and so forth." 8. "Generally the English foot; exceptionally the meter (in ship and boat building)." 9. Marine measurements: "English mile for distance; English foot for drafts." "English system." "The nautical mile is most commonly employed; Lloyd's registry is used in calculating tonnage." "Distances, English mile; tonnage, English ton; draft, English foot."

From a more detailed study of Table 4 it will be seen that although metric units had been in use in Brazil for 56 years and had been obligatory for 30 years at the time of Halsey's study (1919), customary units were still being used by the people in their everyday transactions, as is indicated by column I. Comment 4 in column IV refers to item 16 (land) in column I, and emphasizes the difficulty metric weights and measures have encountered in replacing customary units which have been developed to suit specific purposes and so have become a part of people's thinking. Planters and ranchers find alqueires (11.96 acres) and leguas (4.09 miles) convenient and well adapted to their needs. In the metric scheme there are no comparable measures of surface. Items 17 (lumber and timber) and 18 (carpenters and other woodworkers) are further explained by comment 5, as is item 20 (machine shops) by comment 6 in column IV, while comment 7 makes clear item 24 (sizes of pipe for gas, water, sewers, and so forth) in column I. Comments 8 and 9 refer to items 25 (ship and boat building) and 26 (marine) respectively in column I while comment 9 refers also to item 2 in column II, indicating that in Brazil as everywhere else in the world customary units are used almost entirely in navigation and.for sea measurements. In column II item 3 is explained by the fact that locomotives and coaches have been imported from non-metric countries. A study of column III shows that in general metric units are used exclusively when government inspection and law enforcement can function effectively. It should be noted that item 10 (sizes of pipe) refers specifically to length; item 11 (marine) to freight; and item 15 (railway equipment) to weight. Probably the most significant comment in column IV is the second, which states that "the old Brazilian system [of weights and measures] is still commonly used."

Table 5 summarizes eleven questionnaire replies from Argentina. Here

Table 5. A Summary of Eleven Questionnaire Replies Received by Halsey from Argentina (1919),[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. groceries 2. hardware 3. dry goods 4. ready-made clothing (see comments 3 and 4) 5. hats (see comments 3 and 4) 6. collars (see comments 3 and 4) 7. underwear (see comments 3 and 4) 8. hosiery (see comments 3 and 4) 9. shoes (see comment 5) 10. land (see comment 6) 11. lumber and timber (see comment 7) 12. carpenters and other woodworkers 13. machine shops (see comment 8) 14. smelting and smelter products	1. marine--distance, charts, tonnage, displacement (see comment 10)	1. fruits 2. milk (retail and wholesale) 3. butter and cheese (retail and wholesale) 4. other farm products 5. fish 6. meat (retail and wholesale) 7. flour 8. tea 9. coffee (retail and wholesale) 10. fuel 11. tobacco 12. gloves (see comments 3 and 4) 13. corsets (see comments 3 and 4) 14. stone and brick masons 15. tailors and seamstresses 16. contracts for excavation of ground 17. mines and mining products	1. Metric system adopted in 1863--obligatory in 1887. 2. "The only legal units for any business transaction are those of the metric system, but through a bad habit there has been introduced in common language the indiscriminate use of the American and Canadian legal measurements." 3. "The measurements of ready-made clothing are expressed in the trade in English or metric units according to their source. Clothing, collars, hats, and so forth, imported from England are measured in inches and those from France in metric units." 4. "The best stores have conversion tables to inches." 5. "Imported shoes are in English sizes. Local manufactures are to special Argentine numbers." "The point, corresponding to one-quarter of the old French inch is used." 6. "Lots of land are sold in most cases by the square vara [8.07 square feet]." "In many places the vara [2.84 feet] is used, also the cuadra [284 feet], but these measures are not legal." "In Buenos Aires the old vara [2.84 feet], is still quite frequent." "The real estate dealers are accustomed to sell city lots by the square vara [8.07 feet] although according to law they are liable to a severe penalty." 7. Lumber and timber: "English measurements, though some

1/Ibid., p. 12.

Table 5. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
15. sizes of pipe for gas, water, sewers, and so forth--diameter--soil pipes (see comment 9) 16. ship and boat building 17. marine--freight (see comment 10) 18. grain (wholesale) 19. railway track gages 20. railway equipment (units used in the construction and repairing of locomotives, cars, and so forth)		18. sizes of pipe--gas, water, large sewers, and so forth (see comment 9) 19. hay (wholesale) 20. root crops (wholesale) 21. garden products (wholesale) 22. rubber (wholesale) 23. railway tariff for passengers and freight (load and distance) 24. loads and rates (city transportation) 25. loads and rates (transportation by muleback across mountains) 26. railway (length of lines)	sales are based on length in meters." "Length always in meters; breadth and thickness more often in inches." "Chiefly English measures." "By the cubic meter and square meter for one inch in thickness." 8. In machine shops "sizes are in English measures." "Iron measurements in inches, otherwise the kilo and centimeter." 9. Sizes of pipe: "Meter for large sewer pipes; soil pipes, English and metric; gas and water pipes, inch. 10. Marine measurements: "Distances, maritime miles; charts, feet; tonnage and displacement, same as England and the United States." "English measures." "Although contrary to legal provisions, people use for distance the marine mile. On charts of bays depths are expressed in English feet or in fathoms of 6 feet. Tonnage is expressed in Moorson tons. Displacement is expressed in English tons. Freight--English ton and metric ton."

again the most striking evidence of the data is the very considerable use of customary weights and measures in spite of the facts that: metric units were adopted in Argentina 56 years previous to this study; their use had been obligatory for 32 years; and was strictly enforced by severe penalties. Items 4 (ready-made clothing), 5 (hats), 6 (collars), 7 (underwear), 8 (hosiery), and 9 (shoes) in column 1 are explained by comments 3, 4, and 5 in column IV, indicating that the units in use for imported goods depend largely upon the weights and measures used in the country from which the imports come. Note, however, that for shoes the "point" which corresponds to one-quarter of the old French inch is used, and that special Argentine numbers, also, are used. In column I item 10 (land) is clarified by comment 6, which is significant because it shows the difficulty involved in changing from customary to metric units in the sale and purchase of land. Comment 7 in column IV refers to item 11 (lumber and timber), while comment 8 refers to item 13 (machine shops) in column I. Column II shows that customary units are used exclusively for marine purposes only in Argentina. Column III has eleven more items than has the same column in the table for Brazil, indicating that there is stricter enforcement of metric usage in Argentina, as is the case.

Table 6 gives a summary of four questionnaire replies from Uruguay. As may be seen from comment 10 in column IV the use of metric units is enforced drastically, and yet the items in columns I, II, and IV provide evidence that the law is both ignored and evaded. In column I item 4 (land) is explained by comment 4 in column IV, indicating that here the situation in regard to the use of customary measures of surface is the same as in Brazil, except that the use of these in documents is not permitted.

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Table 6. A Summary of Four Questionnaire Replies Received by Halsey from Uruguay (1919),[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. hats	1. gloves (see comment 3)	1. groceries	1. Metric system adopted in 1862--obligatory in 1867.
2. underwear	2. sizes of pipe for gas, water, sewers, and so forth (see comment 8)	2. milk (retail and wholesale)	2. "The introduction of the new system proved, however, a difficult and tedious process."
3. hosiery		3. butter and cheese (retail and wholesale)	3. Gloves: "As in North America." "Universal numbering."
4. land-farming districts (see comment 4)		4. other farm products	4. "The cuadra [284 feet] is still commonly used (in farming districts) but is prohibited in documents."
5. lumber and timber (see comment 5)		5. hardware	5. Lumber and timber: "Officially the meter, customarily per thousand feet."
6. carpenters and other woodworkers (see comment 6)		6. meat (retail and wholesale)	6. By carpenters and other woodworkers the "English foot and inch are generally used." "English measures generally."
7. tailors and seamstresses		7. flour	7. In machine shops: "Officially the meter and sub-multiples, practically, following the custom, the English inch." "English measures, but in official and public documents these are reduced to centimeters."
8. machine shops (see comment 7)		8. tea	8. Sizes of pipe for gas, water, sewers, and so forth: "Officially the meter, practically the pulgada [0.96 inch]."
9. marine (see comment 9)		9. dry goods	9. Marine measurements: "Officially kilometer, to a large extent the marine mile." "In practice there is no effort to abolish completely the English measures."
		10. fuel	10. "The metric system only has been used in Uruguay for at least fifty years, and anyone who uses any other system runs the risk of fine and
		11. tobacco	
		12. ready-made clothing	
		13. collars	
		14. corsets	
		15. land--smaller towns and cities (see comment 4)	
		16. stone and brick masons	
		17. contracts for excavation of ground	
		18. mines and mining products	
		19. smelting and smelter products	
		20. hay (wholesale)	
		21. root crops (wholesale)	
		22. coffee (retail and wholesale)	

1/Halsey, *op. cit.*, p. 29.

Table 6. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
		23. railway track gages and length of lines 24. ship and boat building 25. grain (wholesale) 26. rubber (wholesale) 27. railway tariff for passengers and freight (load and distance)	imprisonment....In the case of land measurement, a few old Spanish measures are authorized. This letter, according to the laws of Uruguay, must be copied in a letter-press book. Each page of the letter-press book is signed by one of the judges of the Commerce Court and may at any time be required in court. By using, in our correspondence copied in the letter-press book any terms of weights and measures not recognized by law, we run the risk of punishment."

Comments 5, 6, 7, and 9 refer to items 5 (lumber and timber), 6 (carpenters and other woodworkers), 8 (machine shops), and 9 (marine) respectively in column I, and show that when the use of metric units is impractical they are either ignored or evaded. Item 1 (gloves) in column II is supported by comment 3, while item 2 in the same column indicates the prohibitive cost of changing from customary to metric units in such necessities as gas, water, and sewer pipes. Comment 8 refers to this item. Column III indicates the strict enforcement of the use of metric weights and measures. In column IV comments 2 and 10 should be noted especially as they summarize poignantly the situation in regard to metric usage in Uruguay.[1/]

The final step in analyzing Halsey's data was to tabulate it on the master-sheets. Page 92 is a magnigraph of the first master-sheet for

1/See Appendix E, pp. 281-298, for summaries of the questionnaire replies received by Halsey from the other thirteen Latin American countries.

WEIGHT

1. Date	2. Place	3. Country	4. Metric	5. Customary
1919	Pará (3)	Brazil	Kilogram, gram } groceries	arroba - groceries fruits (32.4 lbs. = 1 bu.)
	Manáos (2)	Pp. 14 and 15	Kilogram - fruits	libra - butter and cheese (1.01 lb.)
	Ceará	31 questionnaires	½ kilo - cans of conserves	
	Mossoro			
	Natal		Kilogram - butter and cheese	½, 1, and 7 pound packages of butter
	Pernambuco (2)		¼, ½, 1 and 3 kilo packages of butter	arroba - farm products
	Bahia (2)			
	Goyaz		Kilogram - farm products	
			pound - farm products	
	Bello Horizonte (2)		Kilogram - hardware	
			ton - hardware	
	Rio De Janeiro (3)		Kilogram - fish	arroba - meat
	São Paulo (7)		Kilogram - meat	
	Santos (4)		Kilogram - flour	
	Campinas		Kilogram - tea and coffee	¼, ½, 1, 5 Eng. pounds - cans of tea and coffee
	Curityba		Kilogram - coffee	
	Florianopolis		ton - coal	
	Passo Fundo		Kilogram - coal	
	Porto Alegre		Kilogram - oil	
	Rio Grande		Kilogram - tobacco	onça - fine tobacco (1.01 oz.)
	Bello Huyinta (Horizonte)		ton, Kilogram, gram } machine shops	
	No place given (2)			
	—		Kilogram, gram, ton } mines and mining products	oitava (55.3 grains), carat (3.2 grains) } mines and mining products
	Data not given according to place, therefore the places have been noted geographically from North to South. p. 191		Kilogram, gram, ton } smelting and smelter products	
			Metal tubing for gas and water is measured by weight, per kilogram."	
			ton - freight	
			Kilogram - freight	"Lloyd's registry is used in calculating tonnage"
			Kilogram - hay at wholesale	"Tonnage, English tonnage"
			Kilogram - grain at wholesale	arroba - hay at wholesale
			Kilogram - meat at wholesale	arroba - meat at wholesale
			Kilogram - root crops	arroba, amarrado } root crops at wholesale
			ton - root crops	
			ton - coffee at wholesale	arroba - coffee at wholesale
			Kilogram - butter and cheese at wholesale	libra (1.01 lb.), jaca (14 tall cheeses), arroba } butter and cheese at wholesale
			Kilogram - garden products at wholesale	
			Kilogram - rubber at wholesale	arroba - rubber at wholesale
			ton - railway traffic for freight (load)	
			Kilogram - loads and rates for transportation by muleback across mountains	arroba - loads and rates for transportation by muleback across the mountains
			Kilogram - railway equipment units used in the construction and repairing of locomotives, coaches, etc.	
			Kilogram - railway equipment units	
1919	Posadas	Argentina	Kilogram - groceries	pound - groceries
	Tucuman	Pp. 12, 13, and 14	Kilogram - fruits	
	Mendoza (2)	11 questionnaires	Kilogram - butter and cheese	
	San Isidro		Kilogram - other farm products	
	Rosario		Kilogram - hardware	
	E. Carbo Entre Rios		Kilogram - fish	
	Buenos Aires (4)		Kilogram - meat	
	Bahia Blanca		Kilogram - flour	
			Kilogram - tea and coffee	
			Kilogram - fuel	
			Kilogram - tobacco	

Number of Times Mentioned
Metric - 63
Customary - 34

weight. The column at the extreme left gives the date of the study. The second column indicates the places from which the questionnaire replies were returned. As the data were not recorded by Halsey according to place, the writer arranged the places with reference to their geographical location from north to south. The third column from the left gives the country; the fourth gives the metric units mentioned,[1] together with the commodities for which they were used or the ways in which they were used; and the fifth column gives the customary units mentioned together with the commodities for which they were used or the ways in which they were used. The items, which have been underlined or checked in these last two columns appear also in the field study data, which the writer gathered in the same countries of South America. In the lower right corner the number of times metric units were mentioned is indicated, and also the number of times customary units were mentioned. For this study seven such master-sheets were required; two for weight, three for length, one for capacity, and one for surface. The places tabulated in column II indicate that the most important regions of Brazil were represented. The questionnaire replies from Argentina likewise came from various sections of the country. Those from Uruguay all came from Montevideo, the capital and only important city in that small country. From this tabulation, as has been indicated above, it was possible to get a count of the number of times metric and customary units were mentioned. Thus 278 times customary units were reported in use for commodities, while 355 times, commodities were reported as being weighed or measured by metric units. Therefore the per cent of customary usage was 44% and that of metric 56% showing that approximately as many customary as metric weights and measures were being used.

1/Evidence from other sources indicates the use of the half kilo and other fractions as well as the kilo.

weight. The column at the extreme left gives the date of the study. The second column indicates the places from which the questionnaire replies were returned. As the data were not recorded by Halsey according to place, the writer arranged the places with reference to their geographical location from north to south. The third column from the left gives the country; the fourth gives the metric units mentioned,[1] together with the commodities for which they were used or the ways in which they were used; and the fifth column gives the customary units mentioned together with the commodities for which they were used or the ways in which they were used. The items, which have been underlined or checked in these last two columns appear also in the field study data, which the writer gathered in the same countries of South America. In the lower right corner the number of times metric units were mentioned is indicated, and also the number of times customary units were mentioned. For this study seven such master-sheets were required; two for weight, three for length, one for capacity, and one for surface. The places tabulated in column II indicate that the most important regions of the country were represented. The questionnaire replies from Argentina likewise came from various sections of the country. Those from Uruguay all come from Montevideo, the capital and only important city in that small country. From this tabulation, as has been indicated above, it was possible to get a count of the number of times metric and customary units were mentioned. Thus 275 times customary units were reported in use for commodities, while 353 times commodities were reported as being weighed or measured by metric units. Therefore the per cent of customary usage was 44% and that of metric 56% showing that approximately as many customary as metric weights and measures were being used.

[1] Evidence from other sources indicates the use of the half kilo and other fractions as well as the kilo.

The writer agrees, in general, with the conclusions[1] pertaining to Brazil, Argentina, and Uruguay which Halsey has drawn from his data. In regard to his first conclusion (see page 55), it might be pointed out that the lack of consistency shown in the questionnaire replies is indicative of the evasion or disregard of the compulsory metric laws wherever and whenever this can be managed with impunity. In a country as large as Brazil metric usage, although obligatory by law, cannot be enforced as strictly, if at all, in the interior and in small villages and towns, as it can be within the Federal District. The quoted statements given in the fourth column of Table 6 are supporting evidence for conclusion 2 (see page 55). Tables 4 and 5 indicate that Halsey's third conclusion (see page 55) is a fair one in regard to Brazil and Argentina. A consideration of the fourth conclusion may be omitted as it does not affect Brazil, Argentina, or Uruguay. The last part of conclusion 5 (see page 56), referring to the units used for mechanical purposes and navigation is justifiable. For Brazil comments 6, 8, and 9 in Table 4; for Argentina comments 8 and 10 in Table 5; and for Uruguay comments 7 and 9 in Table 6 are supporting evidence. Conclusion 6 (see page 56) is a fair one provided a phrase is added, so that it will read "in direct relation to the severity of the laws,"[2] and the strictness of their enforcement. Brazil, for instance, has severe laws but these are not enforced vigorously. In regard to the statement that dry goods are commonly sold by the vara (0.91 yard), it should be pointed out that Table 6 indicates that this is not true for Uruguay. The statement regarding imported wearing apparel is supported by comments 3 and 5 in Table 5, and comment 3 in Table 6. Conclusion 7 (see page 56) is substantiated by the

1/See pp. 55-57 of this dissertation for the conclusions which Halsey drew from his Latin American data.

2/See Appendix D, pp. 265-279, for the penalties imposed by Brazil, Argentina, and Uruguay.

data for Brazil only. In Argentina Table 5 indicates that grain only is sold at wholesale by customary units, while Table 6 for Uruguay gives no commodities sold at wholesale by customary units. The eighth conclusion (see page 56) is supported by comments 5, Table 4; 7, Table 5; 4 and 5, Table 6. Halsey's ninth conclusion (see page 56) in regard to tailors and seamstresses cannot be maintained either for Brazil or Argentina inasmuch as Tables 4 and 5 show that they use metric units exclusively. In Uruguay Table 6 indicates that they use both customary and metric units. In regard to stone and brick masons Table 4 for Brazil shows that in these trades both customary and metric units are used, but that in both Argentina and Uruguay they use metric units exclusively as is shown in Tables 5 and 6. Comment 6, however, supports his conclusion regarding carpenters in Uruguay, whereas in Brazil and Argentina the data indicate only that this trade uses both customary and metric units. In regard to machine shops, his conclusion is substantiated by comments 6, Table 4; 8, Table 5; and 7, Table 6. The first part of conclusion 10 (see page 57) dealing with ship and boat building is supported by comment 8, Table 4. In regard to mining, there are no comments, but Tables 5 and 6 show that in Argentina and Uruguay metric units exclusively are used in this industry, while in Brazil Table 4 indicates that both customary and metric units are used. For smelting, likewise, there are no comments, but the data in the tables show that in Brazil and Argentina both customary and metric units are used, while in Uruguay metric units exclusively are used in this industry. Conclusion 11 (see page 57) is substantiated by comments 4 in Table 4; 6 in Table 5; and 4 and 10 in Table 6. In all three tables land is found in the first column, indicating that both customary and metric units are used. The twelfth conclusion (see page 57)

data for Brazil only. In Argentina Table 5 indicates that grain only is sold at wholesale by customary units, while Table 6 for Uruguay gives no commodities sold at wholesale by customary units. The eighth conclusion (see page 56) is supported by comments 5, Table 4; 7, Table 5; 4 and 5, Table 6. Halsey's ninth conclusion (see page 56) in regard to tailors and seamstresses cannot be maintained either for Brazil or Argentina inasmuch as Tables 4 and 5 show that they use metric units exclusively. In Uruguay Table 6 indicates that they use both customary and metric units. In regard to stone and brick masons Table 4 for Brazil shows that in these trades both customary and metric units are used, but that in both Argentina and Uruguay they use metric units exclusively as is shown in Tables 5 and 6. Comment 8, however, supports his conclusion regarding carpenters in Uruguay, whereas in Brazil and Argentina the data indicate only that this trade uses both customary and metric units. In regard to machine shops, his conclusion is substantiated by comments 6, Table 4; 8, Table 5; and 7, Table 6. The first part of conclusion 10 (see page 57) dealing with ship and boat building is supported by comment 9, Table 4. In regard to mining, there are no comments, but Tables 5 and 6 show that in Argentina and Uruguay metric units exclusively are used in this industry, while in Brazil Table 4 indicates that both customary and metric units are used. For smelting, likewise, there are no comments, but the data in the tables show that in Brazil and Argentina both customary and metric units are used, while in Uruguay metric units exclusively are used in this industry. Conclusion 11 (see page 57) is substantiated by comments 4 in Table 4; 8 in Table 5; and 9 and 10 in Table 6. In all three tables land is found in the first column, indicating that both customary and metric units are used. The twelfth conclusion (see page 57)

is supported by comments 9 in Table 4; 10 in Table 5; and 9 in Table 6. The last conclusion (see page 57) cannot, in the opinion of the writer, be justified because the data are not given in sufficient detail. The writer agrees with Halsey's general conclusion.

Kennelly's Data for Continental Europe

Page 97 is a magnigraph of the first master-sheet for weight in the tabulation of the Kennelly data. The first column at the left gives the date; the next the country; and the third column gives the metric units whenever specifically mentioned, otherwise estimates of these have been made, which are indicated by encircled numbers. The column at the extreme right gives the customary units mentioned, subdivided into the three classifications, which Kennelly adopted.1/ In the writer's opinion such classifications are not justifiable, because the units of weights and measures are of primary importance, and not the mechanical apparatus of weighing and measuring. Kennelly's theory carried to its logical conclusion would convert the Babylonian cubit, the Egyptian beq, or the English pound into metric units by the use of mechanical apparatus, invented thousands of years later. The pound, the writer maintains, is still a non-metric or customary unit even though its metric equivalent is 453.6 grams and it is weighed by a metric weighing device. It was not one of the forty-five units of the metric system, as originally invented, nor is it a logical extension of the same, but it is and always will be a non-metric or customary unit, because through the centuries it has survived on the basis of usage.
The numbers in the column headed "Submetricised" indicate the number of units which the writer decided should be placed in the "Non-metric"

1/See p. 63 of this dissertation for Kennelly's definitions of these three classifications.

Master-sheet Number 1 - Kennelly's Study.
WEIGHT

1. Date 1927	2. Place	3. Country	4. Metric	5. Customary: Metricised	Submetricised	Non-metric	Page
					"Precise original values metrically expressed. P,92	"Weighed with non-metric appliances and standards" P.125	
Apr. 28	Nimes	France	9	livre (½ Kilo = 500 gr.) (1 lb.)			29
Apr. 28	Nimes	France		once (25 grams) (1 oz.) livre (½ Kilo) quintol (50 Kilos = 110 lbs) (officially metric quintal = 100 Kilos or 220 lbs.)			30
June	Country districts	France	3	livre (½ Kilo)			39
				livre (½ Kilo)			40
June 27	Provinces	France	1	quintal (50 Kilos)			
July		France	gram			once (gold beaters)	42
July 22	Canton of Pontvallain	France	3	livre (1 lb)			
July 28	Paris	France	9	quintal (110 lb.)		✓containers for fruit 1325	47
Aug. 2	Bouches du Rhône Istres St. Chamas St Mitre	France	1	livre (388.51 grams) livre (379.11 grams) livre (376.63 grams)		(See p. 51.)	51
	Marseilles	France	9	livre (400 grams)			54
June		Belgium	9	livre (500 grams) cheval vapeur (75 kilo-meters per sec.)		Before 1820 livre = 489.5 grams, substantially same as old Fr. pound (P.55)	56, 58
July 4		Belgium		atmosphere (1 Kilo per sq. cm)			59
July 4	Walloon region	Belgium	2	livre (500 grams) - groceries butter			58
		Belgium	1	bouteille (bottle) (about 34 kilos) metallurgy of mercury			59
		Belgium	1	carat (205.5 millgrams) jewelers			
June	Cities and smaller towns	Holland	3	ons pond (500 grams) ons (100 grams)			59
June	Haarlem	Holland	3	sugar candy pond			
June	Delft	Holland		pond ons			
	Amsterdam	Holland	9		2	pond (494.1 grams) pond (apothecary's) (369.1 grams)	60
June 11	The Hague	Holland	9	generally pond (500 grams) Nederlandsch pond (1 Kilogram)			61
June 11	Delft	Holland	9	Nederlandsch pond (1 Kilo) ons (100 grams) lood (10 grams) Wichtje (1 gram)	1	pond (0.5 Kilogram) "nearly related to the metric measure" - used in smaller shops	62, 63
1926 Sept. 23	Zürich	Switzerland	9			denier (0.05 gram) silk	79
1927 April	Pontresina Canton of Grisons	Switzerland	2			rup (17 livres or 8.5 Kilograms) - used by peasants	81
					6	Centner (50 Kilos) Doppel Centner (100 Kilos)	82
April	Country	Switzerland	2			Pfund (500 grams) ✓Krinc	82
1922	Saar-Fee district	Switzerland	2			Various cereals Fischel (about 3 Kilograms)	83

Number of Times Mentioned
Metric - 99
Customary - 43

column in spite of Kennelly's designation. The number of times customary units were mentioned is indicated at the bottom of the sheet together with an estimate for the metric usage. A count was taken for each master-sheet. In this tabulation there were five master-sheets for weight; four for length; four for capacity; and four for surface; a total of seventeen in all.

The following examples indicate how the writer estimated the metric usage. Referring to page 97 it will be seen that for Nimes, France, the Kennelly data gave four customary units: livre or pound, mentioned twice; once or ounce, and quintal (110 pounds, not the official quintal of 100 kilos = 220 pounds). As Nimes is a fair-sized city all the metric weights (kilogram, centigram, milligram, gram, décigram, tonneau, hectogram, décagram, and quintal) except myriagram which has dropped out of use, were included in the estimate, making nine. This figure is probably too high. It is doubtful if milligrams and centigrams were used. Some of the others also may not have been used. For the next estimate, which was for country districts where customary units are more prevalent, since only livre was mentioned among the customary units the metric estimate was three (kilo, gram, quintal), the most commonly used metric weights. As few commodities were mentioned in the data, it was not possible to use these as a basis for estimating, and so the actual units were used. The writer endeavored to estimate the metric usage not only fairly, but generously in every instance.

From this tabulation it was found that customary weights and measures were mentioned 762 times, or according to Kennelly's classification (see page 63) there were 303 metricised, 189 submetricised, and 270 non-metric, while the estimate for metric units was 1967. This gave a percentage of 28% for customary usage and 72% for metric usage. In the opinion of the

writer, therefore, Kennelly's conclusions [1] are at least open to question, since they are definitely out of line with the findings of other investigators, and have specific weaknesses which will be pointed out in the subsequent discussion.

An analysis of the report raises a question in regard to the source of the data, which come chiefly from written statements, obtained by Kennelly from some sixty officials. It has been the writer's experience that any official in a country, where the use of metric weights and measures is compulsory, of necessity in a written statement extols these and declares their "overwhelmingly general use," [2] because the official would jeopardize his livelihood and label himself as incompetent by admitting that, contrary to the law, customary units were still being used to much of any extent within his jurisdiction. In the several instances where the informants are not officials the statements are quite different. For example, the Belgian architect and surveyor, François Engels writes, "There exist, however, in current use, and especially in the country districts names of non-metric measures such as: pieds [feet], bonniers [10.87 acres], verges [rods], journaux [day's work], and many more, all having more or less indefinite meanings, besides varying from one region to another." [3]

Another example is the statement of Herr Dompfarrer Caminada, a Swiss, who has collected old weights and measures. It is as follows: "Officially, the old weights and measures are replaced by the modern system; but in the country, among the peasants there are many who use the old measures in the

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1/See pp. 63 and 64 of this dissertation for a summary of Kennelly's conclusions.

2/Kennelly, op. cit., p. 177.

3/Ibid., p. 57.

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Another example is the statement of Herr Constantin Cardinale, a Swiss, who has collected old weights and measures. It is as follows: "Officially, the old weights and measures are replaced by the metric system; but in the country, among the peasants there are many who use the old measures in the

1/See pp. 60 and 64 of this dissertation for a summary of Kennelly's conclusions.

2/Kennelly, op. cit., p. 177.

3/Ibid., p. 37.

sale of land, hay, and wood (Klafter, Elle, and so forth),[1] and also the old weights, Pfund [1.03 pound], Krine [11.26 quarts], and so forth, for various cereals."[2]

Herr Paul Melchior of Charlottenburg, Germany, also writes, "However, there have remained here and there certain old non-metric units."[3] He then gives some twenty-eight different customary weights and measures. Among these he mentions the Tagwerk (dayswork), the Fuder (wagon load), the rheinischer Zoll (Rhineland inch), and the Pfund (pound). He says of the Pfund, "In war orders employed officially"; of the Doppelzentner (double hundredweight), "Even officially used"; of the Dutzen (dozen), "Very extensively employed"; and he concludes, "There remain certain anonymous units, that are clearly not of metric origin. I am not informed as to their measurement classification; so that I have not classified them in the above categories [metricised, submetricised, and non-metric]."

Moreover in the Austrian newspaper, "Neuen Wiener Tagblatt," was the following announcement: "The Magistrat [in Berlin] assumes for this world exhibition, which is mainly designed as an exhibition of construction, but which may later include industrial art and industrial products, that a total area of 400 Morgen [0.88 acre] will be needed near Mitzleben, with an extension towards Grunewald. Negotiations have begun between industrial groups of the government and the city authorities."[4]

1/Klafter (5.90 feet).
Elle or ell (23.62 inches).

2/Kennelly, *op. cit.*, p. 82.

3/*Ibid.*, pp. 85-87.

4/*Ibid.*, p. 98.

The statement of Mr. Cecil Pinzent, "an English architect, who has resided in Florence for a number of years and is well acquainted with the local habits, customs, and speech" is a further illustration. He writes,

> "In Italy the metric system is known to, and, with one or two exceptions, used for all purposes by educated persons and by official, professional, and commercial classes. On the other hand, the less educated inhabitants of the smaller towns, the inhabitants of villages and the peasant classes in general, though most of them (but not all) are acquainted with the metric system, still tend to use the old measures. This applies less to the north of Italy and more to the south. Even in the bigger towns, it is not unusual to find shopkeepers, who sell their goods to country people by the old measurements, though they buy and keep their accounts by the new. On the farms, the peasants reckon almost exclusively by the old measurements, while the 'fattori' or agents between the peasants and the landowners, use the old system in their dealings with the peasants, and the metric in their dealings with the landowners and the wholesale buyers."1/

He then gives some fourteen different customary measures. He states later,

> "The register of landed property in the Province of Florence (and, I believe, in some other provinces), is kept in square braccia--1 braccio (arm) is 2 palmi (palms)2/....On contracts for purchase of land and in calculations for the tax on purchase, the area is given in square braccia, while the equivalent in square meters is sometimes omitted....Even in Florence some shopkeepers sell their cloth to country people by the braccio, though they do their own reckonings in meters....Staio (bushel) is used by practically all peasants for measuring cereals (and from this is derived the staio of land, still sometimes used, which means as much land as can be sown with a staio of seed)....Barile (barrel) [and fiascho or flask,3/ for wine and oil respectively are] used by practically all peasants....[while the] libbra (pound) of 0.34 kilogram [0.75 pound is] used in most towns and villages and at fairs for eatables."

It should be noted that this libbra is 340 grams and not the 1/2 kilo (500 grams).

1/Ibid., pp. 110-111.

2/Square braccia (3.65 square feet).
Braccio (22.95 inches).
Palm (11.48 inches).

3/Barile (12.08 gallons or 8.85 gallons).
Fiascho (2.42 quarts or 2.21 quarts).

Mr. Franklin C. Gowen, the American Vice Consul at Rome also writes,

> "I have discovered the continued existence of a number of names of primitive units such as canna [cane], braccio [arm],1/ libbra [pound], and so forth, among the people; but I have not been able to find or recall any case where such a unit exists as a working measure in buying or selling....Of course, I do not mean to say that no cases exist of such units being employed somewhere in the country, because such use would be illegal and parties would naturally be unwilling to make statements that might lead to legal complaints."2/

A few days later Mr. Gowen sent an unsigned letter, which gives some nine different customary measures. The letter says,

> "In the Umbria region, for example, the rubbio [624.02 pounds] and coppa [cup] are used for the sale of cereals among private individuals, especially wheat....For firewood, besides using weights or measures, in the Umbria region there is also used the soma, which consists in that quantity of wood, which a mule or donkey can carry on its back....Should you wish to consult Bemporad's Pocket Encyclopaedia you will find in it numerous systems of weights and measures still used in various regions of Italy."3/

An Italian member of the American Consulate staff at Messina, Mr. Carlo Favoloro, likewise made the following statement,

> "After the year 1860, the new system was inaugurated, but in many places, especially in the provinces, the use of the old weights and measures still prevails. Private contracts, goods on sale, land, and so forth, are almost all made and sold by using the old weights and measures. It has been shown that in Barcelona, Milazzo, Santa Lucia del Mela, Patti, Montalbino, Elicona, and so forth, (all in the province of Messina), sales are made by the old weights and measures. Here it seems necessary to say that measures, as well as weights, also having the same denomination are different, comparing them to the 'Sistema in Corso' (metric system)."4/

Mr. Favoloro then gives some 22 different customary weights and measures, and adds, "It is impossible to give all the names of the measures and

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1/Canna (6.95 feet).
Braccio (22.95 inches).

2/Kennelly, op. cit., pp. 119-120.

3/Ibid., p. 121.

4/Ibid., p. 126.

weights used, and their equivalents in kilograms and square meters, as their value varies in different places." 1/

The Mayor of Cagliari, in spite of being an official, sent to the American Consulate at Rome a "List of the Principal Remaining Old Units" 2/ still in use in Sardinia. This list included some 32 different customary weights and measures. The mayor's name is not recorded. Under the seven "Land Surface Measures" the following note appears, "These measures correspond to the quantities of wheat required for the sowing of the respective surface areas," which indicates that these too are customary measures. Likewise the Mayor of Nuoro, whose name also is not recorded, wrote to the American Consulate at Rome, "Only in private affairs certain of the old measures are still employed. These are, however, limited to weight (the libra of 400 grams, divided into 12 ounces), and to measures of capacity (the quarto of 1.25 liter, 3/ divided into 4 paris)" 4/ or parts. Again it should be noted that this libra (pound) is less than the half kilo (500 grams). The above non-official statements from individuals who have nothing to fear by giving unbiased information, together with the above unsigned official statements do not corroborate the signed official statements in regard to the "overwhelmingly general use" of metric weights and measures in Europe.

It should also be noted that Monsieur Pomey wrote, after quoting from the Code of Rural Customs of the Canton of Pontvallain some 19 customary measures still used in the Canton:

1/*Ibid*., p. 127.

2/*Ibid*., p. 132.

3/Libra (0.88 pound).
Quarto (1.14 quart).

4/Kennelly, *op. cit*., p. 133.

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It should also be noted that Monsieur Frary wrote, after quoting from the Code of Rural Customs of the Canton of Fontvaillais some 13 customary measures still used in the Canton:

1/Ibid., p. 127.

2/Ibid., p. 128.

3/Libbra (0.88 pound).
Quarto (1.14 quart).

4/Kennelly, op. cit., p. 103.

"You can procure at Le Mans....the Local, Town, and Rural Customs of the Department of Sarthe....and you can obtain similar information for all the Departments of France, so as to ascertain just how far the old terms persist, by directing enquiries, not to the Mayors, but to the Justices of the Peace in the various cantons. It is these latter who are the best and most reliable sources of information, more reliable than the notaries; because only modern legal terms are employed in notarial deeds; the current language of the countryside is used in the disputes between farmers...."1/

and yet Kennelly apparently left unexplored this source of information, for among the sixteen written statements obtained in France, there is not one from a Justice of the Peace.

The writer furthermore cannot agree with certain statements which Kennelly has made in his introduction. The first is in regard to the "wonderful sociological phenomenon"2/ which has taken place in continental Europe since 1800. He says that,

"a group of more than thirty countries with an aggregate population today exceeding three hundred millions, have, one after another, officially adopted the metric system to the abolition of their respective national systems. The change has been voluntary. In no case, so far as the writer /Kennelly/ has been able to discover, did the change from national to metric measures come about in any one country, at the dictation of any other country. The change, always effected at appreciable inconvenience and expense, was made for the sake of the greater simplicity of the new system, as well as for advantages in international commerce and communication."3/

While setting aside Soviet Russia and Turkey, Kennelly neglects to mention England and her empire. Literally speaking, England may not be a part of continental Europe, but, practically, she is the greatest commercial and industrial nation of Europe. Moreover the British Isles have a population of more than 40 million, but the British Empire has more than 472 million

1/*Ibid.*, p. 47.

2/*Ibid.*, p. viii.

3/*Ibid.*, p. ix.

people[1] who, for the most part use customary weights and measures. If to this number is added the population of the other leading commercial and industrial nation in the world today, the United States,[2] more than 600 million people are still using non-metric or customary weights and measures. Then to say that the change to metric units has been voluntary on the part of the respective governments may be true in a way, but leaves much unsaid. It can hardly be claimed that the abolition of the customary systems and the compulsory establishment of the metric scheme has been in accordance with the will of the majority of the people of Europe. Confiscation, penalties, and compulsion have accomplished a nominal use, but even these have failed to abolish the most convenient and useful of the customary units. The adaptations, which will be discussed later, the metric scheme has been forced to make in every country is concrete proof of this. Likewise the "advantages in international commerce and communication" are questionable, due to the fact that such a large proportion of both of these is carried on by Great Britain and the United States, which are non-metric nations.[3]

The first adaptation of the metric system to customary weights and measures took place in France itself seventeen years after this new system had been adopted, and only thirteen years after the establishment of its standards. It was in 1812, when Napoleon, in his February twelfth decree,[4]

1/Foreign Commerce Yearbook 1938, p. 427. See also Paul Sullivan, War Atlas, New York: Doubleday Doran, 1939, p. 32.

2/The World Almanac and Book of Facts, New York: New York World-Telegram, 1940, p. 337.

3/Of the total world trade in 1937 approximately 41% of the imports and 38.2% of the exports. Foreign Commerce Yearbook 1938, p. 426.

4/Bigourdan, op. cit., pp. 194-198.

made a practical compromise by suspending, except in the schools and government offices, the unpopular metric system, and by establishing the "système usuel," based on the customary weights and measures of Paris,[1] which "were generally used in trade, and were best suited to the needs of the people." The following were restored:

toise = 6 pieds (feet) = 6.56 feet[2]
pied (foot) = 12 pouces (thumbs) = 13.12 inches
pouce (thumb) = 12 lignes (lines) = 1.09 inch
ligne (line) = 0.09 inch
aune (ell) = 47.24 inches
1/2 aune (ell) = 23.62 inches
1/4 aune (ell) = 11.81 inches
1/8 aune (ell) = 5.90 inches
1/16 aune (ell) = 2.95 inches
1/3 aune (ell) = 15.75 inches
1/6 aune (ell) = 7.87 inches
1/12 aune (ell) = 3.98 inches
boisseau = 1.42 peck or 12 quarts
double boisseau = 2.84 pecks
1/2 boisseau = 6 quarts
1/4 boisseau = 3 quarts
livre (pound) = 16 onces (ounces) = 1.10 pound
1/2 livre (pound) = 0.55 pound
1/4 livre (pound) or querteron = 4.37 ounces
1/8 livre (pound) or demiquart = 2.18 ounces
once (ounce) = 8 gros = 1.196 ounce
1/2 once (ounce) = 0.598 ounce
1/4 once (ounce) or deux gros = 0.27 ounce
gros = 72 grains or 0.16 ounce
grain = 0.07 grain
1/2 litre = 0.45 quart or 1 pint
1/4 litre = 0.23 quart
1/8 litre = 1.11 quart
1/16 litre = 0.06 quart

Napoleon was too practical-minded to disturb trade again by any change in the existing standard units, although, that he was only too well aware of the shortcomings of the metric system, is evident for he remarked in his "Mémoires," "It violently broke up the customs and habits of the people as

1/ Ibid., p. 20.

2/ The old toise was 6.39 feet.

might have been done by some Greek or Tartar tyrant, who with uplifted rod, wills to be obeyed in all his decrees, regulated by his prejudices or his interests, without any regard for those of the conquered....It is tormenting the people for trifles."1/ Furthermore, in 1837 when the repeal of the 1812 decree and the restoration of the decimal metric system of 1799, except for the measures of time, were being discussed, the statement was made in the Chamber of Deputies that, "The old weights and measures which we have wanted to destroy, after so many years of trying to accomplish this, still remain and are used in a very large number of localities."2/

Other examples of the adaptation or modification of metric units may be seen in the cases of the libbra (pound) and the palmo (palm). The libbra, Kennelly says,

> "Seems to have been metricised at different metric values in different parts of the Italian Kingdom....In Florence it is taken as 1/3 kilogram /333 grams or 0.74 pound/. In Rome the writer bought candy by the libbra in one shop at 250 grams /0.55 pound/ and in another at 500 grams /1.10 pound/. In Sardinia, where it seems to be spelled 'libra,' or in the Spanish fashion, it passes as 400 grams /0.88 pound/."3/

The Sicilian libbra is 317 grams (0.69 pound). In Barcelona, the leading Spanish mercantile and shipping port on the Mediterranean, the official Tables of Equivalents assign 400 grams (0.88 pound) to the libra,4/ while in Palma, Majorca, it weighs 407 grams (0.875 pound).5/ This latter, Kennelly says, was the only instance he was able to find in all Europe of

1/*Mémoires de Napoléon*, p. 218.

2/Bigourdan, *op. cit.*, p. 202.

3/Kennelly, *op. cit.*, p. 122.

4/*Ibid.*, p. 141.

5/*Ibid.*, p. 149.

non-metric weights being used commercially[1]--a statement to be questioned due to the foregoing evidence. These data, moreover, indicate that the compulsory use of metric units, while intended to give uniformity, has really increased diversity in weights and measures. The libra, for instance, if recognized by law and separately defined, would be uniform in a nation whereas refusal to recognize it permits local translation into legal metric units. Also in Barcelona there are

> "two different palmos /palms/ in use. One is the old palmo /7.68 inches/, one-eighth of the Barcelona vara /61.42 inches/. The other is the modern or metricised palmo, mentioned in the last letter as being just 0.2 meter /7.87 inches/. In common use the metric palmo /7.87 inches/ is referred to; but in land sales, the old square palmo /58.98 square inches/ is retained, as it fetches a larger price by nearly 6%. This differential in favor of the old square palmo commercially helps to keep it alive."[2]

More recent examples of metric adaptation to customary weights and measures may be found in the statement of the Secretary of the Czechoslovakia Standardizing Commission. He writes,

> "With regard to the screw bolts and nuts for the Whitworth thread, with the exception of the thread, all other dimensions are standardized in millimeters.[3] For the widths across the flats of the hexagonal nuts and boltheads, the so-called universal series has recently been accepted by the C.S.C. /Commission/, which is virtually a compromise between the Whitworth and the metric standards, and which enables one series of spanners to be used for both of the above named standards. This example shows that, standardizing in millimeters, it was possible to maintain a practical interchangeability not only with the screw bolts, but also with rivets standardized in inch measures.... The inch measures formerly used may perhaps be the origin of dimensions of certain articles now standardized in metric measure, for example, the rolled steel sections, round, square, rectangular, flat; the thickness of plates; and many others....it is in practice easily possible to find metric dimensions rounded to millimeters, which are very nearly equivalent to inches rounded to sixteenths of an inch, especially when

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1/*Ibid.*, p. 150.

2/*Ibid.*, p. 140.

3/Millimeter (0.0394 inch).

> the usual practical tolerances are admitted....It may be said that, on the one hand, the origin of dimensions from the inch measures is an obstacle to an achievement of ideal metric standards, but, on the other hand, it may be rather helpful, now, when the different nations are endeavoring to achieve possible international standards, to standardize in millimeters those articles which would be practically interchangeable with the British and American standards."1/

France, too, has officially adopted the customary unit tonneau de jauge or gage-ton (100 cubic feet), 2/ while in Germany the customary weights, Pfund (pound) and Doppelzentner (double hundredweight) are taught in the schools and used officially. 3/

Another statement which is open to question in the light of the evidence from the writer's study of six French arithmetic books, is the one, in which Kennelly says that he "was able to ascertain by enquiry, and by examination of various modern elementary school books of elementary arithmetic in France, that only the metric system is taught in the French schools, with no units other than the metric units and their decimal derivatives." 4/ The writer, however, has found first that a number of customary weights and measures are included in these books. For instance, the customary weights quintal (100 kilos) and tonne (1000 kilos) 5/ have been added to the metric scheme, although "their denominations are an exception to the rule of denomination of multiples." 6/ Lieue or league (2.48 miles) is another customary measure which has been taken over. In regard to this unit Lemoine says,

1/Kennelly, op. cit., pp. 103-104.

2/Ibid., p. 53.

3/Ibid., p. 85.

4/Ibid., p. 54.

5/100 kilos (220.46 pounds).
1000 kilos (2204.6 pounds).

6/Kennelly, op. cit., p. 46.

"In language 'usuel' one sometimes also expresses long distances in lieues metriques (4 kilometers). Note: one should accustom himself to reckoning great distances in kilometers /0.62 mile/ and not in lieues."1/ A fourth adopted customary unit is the livre or pound (500 grams), "which is used sometimes,2/ but does not belong to the metric system."3/ Carat (2 déci-grams)4/ is a fifth customary weight which has been incorporated into the metric scheme,5/ while the customary unit of volume, stère (1.31 cubic yard), has been added, likewise, to measure firewood.6/

But these are not all. There are a large number of "mesures effectives or réelles--those which actually exist; those which the law permits to be made, and used"7/ practically in commerce and industry.8/ The word "mesures" refers both to weights and measures, and to instruments of measuring. Considering the former, first, "effective or real measures are those which are really used in measuring." These legal exceptions consist of the principal units and certain secondary units together with their doubles and halves.9/

1/Lemoine, op. cit., p. 72.

2/Wilson found it much used. See Wilson, Stone, and Dalrymple, op. cit., p. 256.

3/Camman and Huot, op. cit., p. 262.

4/4 kilometers (2.48 miles).
500 grams (1.10 pound).
2 décigrams (3.09 grains).

5/Chenevier, op. cit., p. 222.

6/Lemoine, op. cit., p. 147.

7/Ibid., p. 70.

8/M. Delfaud and A. Millet, Arithmétique, Cours Moyen et Supérieur, Paris: Hachette, 1928, p. 200. See also Chenevier, op. cit., p. 219.

9/Maurice Royer and Planel Court, Arithmétique, Cours Moyen, Paris: Armand Colin, 1929, p. 68.

They are:

Length	Approximately
décimètre (3.94 inches)	1/8 yard
double-décimètre (7.87 inches)	1/4 yard or link or 1/6 aune (ell)
demi-mètre (19.69 inches)	1/2 yard or 1/2 aune (ell)
mètre (39.37 inches or 3.28 feet or 1.09 yard)	yard
double-mètre (6.56 feet)	fathom or toise
demi-décamètre (16.40 feet or 5.47 yards)	rod
décamètre (32.80 feet)	
double-décamètre (65.60 feet)	furlong or chain

Capacity (Dry and Liquid)	
hectolitre (2 bushels, 3.35 pecks or 26.42 gallons)	barrel
demi-hectolitre (1 bushel, 1.68 peck or 13.21 gallons)	bushel
double-décalitre (18.16 quarts or 5.28 gallons)	1/2 bushel
décalitre (9.08 quarts or 2.64 gallons)	
demi-décalitre (4.54 quarts or 1.32 gallon)	1/2 peck or gallon
double-litre (1.82 quart or 2.12 quarts)	
litre (0.908 quart or 1.06 quart)	quart
demi-litre (0.45 quart or 0.53 quart)	pint
double-décilitre (12.20 cubic inches or 1.69 gill)	1/2 pint
décilitre (6.10 cubic inches or 0.85 gill)	gill
demi-décilitre (3.05 cubic inches or 0.42 gill)	1/2 gill
double-centilitre (1.22 cubic inch or 0.68 fluid ounce)	fluid ounce
centilitre (0.61 cubic inch or 0.34 fluid ounce)	

There are four series of effective measures of capacity:

1. For dry measure (grains, vegetables, fruits, and so forth)[1/] --11 measures from demi-décilitre (3.05 cubic inches) to hectolitre (2 bushels, 3.25 pecks)

2. For wholesale liquids (wine, and so forth)--5 large measures from demi-décalitre (1.32 gallon) to hectolitre (26.42 gallons)

3. For retail commerce--8 little measures from centilitre (0.61 cubic inch or 0.34 fluid ounce) to double litre (1.82 quart or 2.12 quarts)

4. For milk and oil--5 special measures from décilitre (0.85 gill) to double litre (2.12 quarts)[2/]

1/Lemoine, op. cit., p. 113.

2/Royer and Court, op. cit., p. 90.

Weight	Approximately
milligramme (0.015 grain)	
double-milligramme (0.021 grain)	
demi-centigramme (0.077 grain)	
centigramme (0.154 grain)	
double-centigramme (0.308 grain)	
demi-décigramme (0.771 grain)	
décigramme (1.543 grain)	
double-décigramme (3.086 grains)	carat
demi-gramme (7.716 grains)1/	
gramme (15.432 grains or 0.035 ounce)	
double-gramme (30.86 grains)	
demi-décagramme (0.176 ounce)	dram
décagramme (0.353 ounce)	
double-décagramme (0.706 ounce)	ounce
demi-hectogramme (1.765 ounce)	1/8 pound
hectogramme (3.53 ounces)	1/4 pound
double-hectogramme (7.06 ounces)	1/2 pound
demi-kilogramme (1.102 pound)	pound or livre
kilogramme (2.205 pounds)	
double-kilogramme (4.41 pounds)	
5 kilogrammes (11.025 pounds)	
10 kilogrammes (22.05 pounds)	quarter
20 kilogrammes (44.10 pounds)	
demi-quintal (110.25 pounds)2/	hundredweight

Firewood

To estimate the volume of firewood and sometimes to estimate in building:

stère (1.308 cubic yard)3/
double-stère (2.616 cubic yards)
"ancien" demi-décastère (6.540 cubic yards)4/
double-décastère (26.16 cubic yards)5/

The height of the posts varies, according to the length of the logs, in a

1/Lemoine, op. cit., p. 232. The above are used for weighing precious material.

2/Royer and Court, op. cit., p. 232.

3/Stère (1 cubic mètre).
Demi-décastère (5 cubic mètres).
Double-décastère (20 cubic mètres).

4/Royer and Court, op. cit., p. 212.

5/Camman and Huot, op. cit., p. 250.

manner so as always to produce a solid of 1, 2, or 5 cubic mètres. There are no effective measures of surface, 1/ because surfaces are not measured, but calculated. 2/ Of effective measures, most of which approximate the convenient customary units, there are 49, or, not including principal and secondary units, 33, while in the original metric system there were only 45 not including the franc, 3/ four of which are not used officially.

It should be noted here that the double-mètre (6.56 feet) is the toise 4/ of the Napoleonic "systême usuel," while the demi-mètre (19.69 inches) is approximately the 1/2 aune (ell), and the double-décimètre (7.87 inches) the 1/6 aune (ell). Also the demi-kilogramme is the livre (pound). Other such units, retaining even the customary names, still in use are:

boisseau 5/ (1.42 peck or 12 quarts)
quintal 6/ (220.46 pounds)
tonneau 7/ (2204.6 pounds)
pied 8/ or foot (13.12 inches)
pouce 9/ or thumb (1.09 inch)
ligne or line 10/ (0.09 inch)--used in printing
once or ounce 11/ (1.196 ounce)--used by gold beaters

1/*Ibid.*, p. 237.

2/Delfaud and Millet, *op. cit.*, p. 214.

3/There are five principal units: mètre, are, stère, litre, and gramme; and eight prefixes: myria, kilo, hecto, déca, déci, centi, milli, dimilli.

4/Kennelly, *op. cit.*, p. 39.

5/*Ibid.*, pp. 32, 39, 46. See also Bigourdan, *op. cit.*, p. 196.

6/Kennelly, *op. cit.*, pp. 30, 40, 46. See also Bigourdan, *op. cit.*, p. 80.

7/Kennelly, *op. cit.*, pp. 39, 53.

8/*Ibid.*, pp. 32, 39, 46, 49. See also Bigourdan, *op. cit.*, p. 195.

9/Kennelly, *op. cit.*, pp. 32, 39, 46.

10/*Ibid.*, pp. 42, 46, 49.

11/*Ibid.*, pp. 30, 42.

Thus of the twenty-nine customary weights and measures restored by the 1812 decree, a third of them are still in use, although prohibited in 1840.

The effective or real instruments of measuring length, according to current usage, are:

> the décimètre (3.94 inches), and double-décimètre (7.87 inches) ruler (including centimètres (0.39 inch), millimètres (0.039 inch) and sometimes demi-millimètres (0.0195 inch) for the use of draughtsmen;1/ the mètre (39.37 inches) and demi-mètre (19.69 inches) stick for the use of shopkeepers, selling cloth;2/ the mètre (39.37 inches) and the demi-mètre (19.69 inches) tape measure (not legal) for the use of seamstresses, tailors and milliners;3/ the folding décimetre (3.937 inches) rule of ten equal sections for the use of joiners,4/ and the folding mètre (39.37 inches) rule of five or ten equal sections for the use of wood and iron workers; the folding double-mètre (6.56 feet) rule and the folding demi-mètre (19.69 inches) rule; and the demi-décamètre (16.40 feet), décamètre (32.80 feet), and double-décamètre (65.60 feet) steel tapes, or the surveyor's 10 mètres chain (32.80 feet), composed of fifty iron rods, each two décimètres (3.94 inches) long and joined by links, for measuring land.5/

Demi-décamètre (16.40 feet) and double-décamètre chains (65.60 feet) are also used. Masons, joiners, and draughtsmen measure angles by the customary square.6/ All these are more concrete proof of the adaptations the metric scheme has had to make to the needs and convenience of commerce and industry. It is not difficult, under the circumstances, to agree with Napoleon, that an easier road to simplification could have been found through retention of the customary measures and their better standardization.

On April 2, 1919, a new system of weights and measures was established

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1/Lemoine, _op. cit._, p. 70.

2/Chenevier, _op. cit._, p. 208.

3/Delfaud and Millet, _op. cit._, p. 200.

4/Royer and Court, _op. cit._, p. 34.

5/Delfaud and Millet, _op. cit._, p. 201.

6/Lemoine, _op. cit._, p. 73.

in France by law, and made obligatory July 26, 1920. It is called the "système M.T.S.," so named because its fundamental units of length, weight, and time are the mètre, tonne, and seconde. "Recent scientific progress, and the development of certain industries have necessitated the creation of new units of measure," 1/ is the explanation given for the establishment of these new commercial and industrial units." 2/ The principal units are:

geometric, including length, surface and land measures, volume (capacity and firewood), and angles
weight
time
mechanics
electric
heat
optics

For angles the unit is the right angle. "It may be divided into grades or degrés." Thus the customary degree, minute, and second have been incorporated into this new system.

degré--1/90 of a right angle
minute--1/60 of a degré
seconde--1/60 of a minute

The table for time, likewise, is made up of customary units, and these are not "nombres decimaux." 3/

seconde--1/86,400 of the mean solar day
jour--86,400 secondes--24 hours
heure--3,600 secondes--60 minutes
minute--60 secondes 4/

Some new units which this law established are: 5/

sthène (sn)--"the unit of force which applied during one seconde of time to a mass of one metric tonne, produces an increment of velocity amounting to one mètre per seconde. A sthène is approximately equal to the weight of 102 kilogrammes."

1/Delfaud and Millet, *op. cit.*, p. 238.

2/Chenevier, *op. cit.*, p. 204.

3/*Ibid.*, p. 230.

4/*Ibid.*, p. 239.

5/Kennelly, *op. cit.*, pp. 51-52.

pièze (pz.)--the unit of pressure intensity "which applied uniformly over a surface of one square mètre produces a total force of one sthène. A kilogramme per square centimètre is approximately 102 pièzes."

hectopièze--"employed, under the name of the bar, for expressing barometric pressures."

kilowatt--"substituted for the cheval-vapeur /horsepower/."

calorie--the unit of heat, "which communicated to a mass of one kilogramme of water at the mean temperature of 15 degrees centigrade raises its temperature one degree centigrade." The equivalent of 423 new calories are approximately 426 old calories.

angström--the "international unit for the measurement of luminous wave lengths" equals 10^{-8} centimètre.

"These new metric units have some little difficulty in becoming established; but the scientists are beginning to use them," writes Monsieur Pomey, Inspector General of Postal Telegraphs and Director of the School of Advanced Studies in the Postal Telegraph Service (retired).

Still other customary units are used and are designated as complex numbers (not in the decimal system).1/ For measuring time, for instance, besides the units, day, hour, minute, and second, adopted by the M.T.S. system, are:

année--12 months or 365 days (366 every four years) or 52 weeks and one day (52 weeks and two days every four years)

mois--30 or 31 days except February which has 28 (29 in leap year)2/

semaine--7 days

To quote from Royer's Arithmétique,

> "The old French measures....did not follow the decimal numeration....Such are still today the units for measuring time, circumference, and angles 3/....The length of a circumference is divided into 360 degrees; a degree into 60 minutes; and a minute into 60 seconds. The measurement of an arc is also expressed in degrees, minutes, and seconds. An arc of a half-circumference has 180 degrees; an arc of a quarter-circumference (quadrant) has 90 degrees. Some units of length are derived from a degree of the terrestrial meridian. The meridian is the circumference of the earth passing through the two poles. These measures are still in use among geographers and mariners."4/

1/Chenevier, op. cit., p. 253. See also Royer and Court, op. cit., p. 244.

2/Lemoine, op. cit., p. 31.

3/Royer and Court, op. cit., p. 244.

4/Ibid., p. 246. See also Delfaud and Millet, op. cit., p. 199, and Chenevier, op. cit., p. 209.

They are:

degré--1/360 of a meridian
lieue marine--1/20 of a meridian degree
mille marin--1/60 of a meridian degree (1,853 mètres or 6077.84 feet)[1]
noeud marin--1/120 of a mille marin (50.62 feet)

From the above it will be seen that in France today the weights and measures, which are in practical use, are quite different from the forty-five of the original metric system. There are admittedly two schemes: le système métrique and le système M.T.S.; actually there are three in use, for many customary units also survive, and all of these are taught in the French schools.

A statement in the Kennelly report with which the writer agrees is the following by Monsieur Pomey, retired Director of the School of Advanced Studies in the Postal Telegraph Service. He says, "We have everywhere in France compulsory primary school education, and this primary schooling assigns a part--in my opinion an unnecessarily large part--to the metric system, as may be seen by consulting school books. This teaching has now been maintained for a considerable number of generations, and it has been fairly well maintained since the time of Jules Ferry [1881]."[2] The data from a study which the writer made of six French arithmetic books, shown in Table 7 (see page 118), indicate that from 14 to 20% of the pages in three French elementary arithmetic books is given to the study of metric weights and measures; 11 to 13% in two intermediate arithmetic books; and 9% in an advanced arithmetic book. Of necessity the part assigned to the teaching of metric units in the French primary schools must be large because the work is memorization to a great extent,[3] and does not fit in with the children's experience which

1/Nautical mile (6080 feet).

2/Kennelly, op. cit., pp. 44, 53.

3/Ibid., p. 42.

Table 7. The Number of Pages and the Per Cent of the Text Given to the Study of Metric Weights and Measures in Six French Arithmetic Books.

Textbook	Total Number of Pages	Number of Pages Given to Metric Units	Per Cent
Arithmétique-Cours Élémentaire (1st and 2d years). Delfaud and Millet. 1930..................................	182	26	14%
Cours Élémentaire d'Arithmétique. Camman and Huot. 1923..............	332	51	15%
Arithmétique-Cours Élémentaire et Moyen. Lemoine. 1929...............	188	39	20%
Arithmétique-Cours Moyen (1st year). Royer and Court. 1929..............	307	40	13%
Arithmétique-Cours Moyen et Supérieur. Delfaud and Millet. 1928...........	309	44	11%
Précis d'Arithmétique-Secondary. Chenevier. 1928....................	431	38	9%

includes the many customary weights and measures in actual use. Wilson, however, in his European investigation[1/] discovered that the most progressive schools in France do not teach the decimalization of the metric scheme. The children, it has been found, can grasp quite easily the fundamental units and their binary fractions; such as 1/2, 1/4, 1/8, and so forth, which are commonly used, but as soon as they are forced into the theoretical realm, they are confused and only meaningless memorization results. As a matter of fact, secondary units, designated by the prefixes mega (million), hectokilo (hundred thousand), myria (ten thousand), décimilli (ten thousandth), centimilli (hundred thousandth), micro (millionth), and millimicro (thousand

1/Wilson, Stone, and Dalrymple, op. cit., p. 256.

millionth) have been found to be impractically large or small, and consequently are now almost disregarded. Of the fourteen Greek and Latin prefixes prescribed by the original metric system only six, or less than half, are used at all commonly;[1] while myriamètre (10,000 mètres), myriagramme (10,000 grammes), kilolitre (1000 litres), myriamètre carré (10,000 square mètres), décastère (10 stères), and centistère (1/100 of a stère) are no longer used officially.[2] Camman and Huot state that the kilolitre (1000 litres) "is used little" and the myrialitre (10,000 litres), the millilitre (1/1000 of a litre), and the myriagramme (10,000 grammes), are "not used at all."[3] In the Bologna arithmetical primer,[4] as well as in the Madrid elementary arithmetic book[5] mentioned by Kennelly, about 40% of the pages in both are given to the study of the metric weights and measures, while in an elementary school arithmetic book used in Burgos, 17% of its pages deal with metric units.[6]

The writer also finds evidence of bias in the terminology of the Kennelly report. For instance, in the title the words, "Metric-system Europe," are misleading, for, as has been pointed out above, the English system of weights and measures is used by over 40 million people in the British Isles.

1/Chenevier, op. cit., p. 205.

2/A. Lemoine, Arithmétique, Paris: Hachette, 1929, pp. 68, 90, 108, 119, 147.

3/Camman and Huot, op. cit., pp. 43, 267.
    mètre (3.28 feet or 1.09 yard)
    gramme (0.04 ounce)
    litre (1.06 quart)
    square mètre (10.76 square feet or 1.20 square yard)
    stère (35.32 cubic feet or 1.31 cubic yard)

4/Ibid., p. 115.

5/Ibid., p. 137.

6/Ibid., p. 144.

Then, to omit the phrase, "in the Internal Commerce" gives a wrong impression, because Kennelly gives only minor attention,[1/] if any, to the units used in the very important areas of manufacturing, industry, and external commerce.[2/] Furthermore, "Persisting," which is used a number of times in the report, as well as in the title, suggests disapproval of customary units, while "Pre-Metric Weights and Measures" over-emphasizes the importance of the metric scheme. "Vestiges" also implies the decline of customary weights and measures, and throughout the report the word "primitive" is used to designate customary units--"those which they had used prior to their adoption of the international Metric System," in spite of the fact that in metrology primitive designates units used by primitive man. By using this latter term the impression is given that all customary weights and measures belong to the era before the dawn of civilization. "Crude" is another disparaging word which is applied several times to customary standards. Kennelly says, "Perhaps a few crude non-metric standards, like the canna /6.79 feet/ and boccale /9.09 quarts/ may be found among the farmers" (of Sicily),[3/] and "Nevertheless, on the farms, local measures of volume are maintained here and there, probably in crude form."[4/] Then, to refer to the "metric system" as international, and to capitalize the words serves to give them enhanced prestige. Another phrasing, which indicates bias, appears in the following, "In Germany today, we find....the Pfund /pound/ and Doppelzentner /double hundredweight/ are strongly entrenched as elements of the metric system taught in the

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1/Kennelly, op. cit., p. 3.

2/Ibid., p. 179.

3/Ibid., p. 129.

4/Ibid., p. 145.

schools."[1/] Considering that the history of the customary unit, "Pfund," can be traced back to the early civilizations of Asia and Egypt,[2/] to designate it as an "element of the metric system" is hardly justifiable. That these are measures existing and used independently of the metric scheme would appear to be nearer the truth.

Not only is there evidence of bias in the terminology used by Kennelly, specific instances of which have been cited, but the study itself seems to the writer to indicate bias. Throughout, the impression is given that the use of metric units indicates superior education, if not higher intelligence. On this point, Kennelly writes, "The prevalence of these [customary units in Italy] may have some correlation with the extent of illiteracy in the different regions,"[3/] while in conclusion he says, "To find vestigial premetric units, enquiries have to be directed to the verbal, unrecorded statements of country folk, where the quantities mentioned become doubtful, indefinite, and ambiguous."[4/] It is probable, however, that these customary weights and measures are continued in use simply because they are more specific and definite in the minds of the people using them than would be any serviceable metric unit.

Further evidence of bias is that any findings for which Kennelly cannot account metrically, he disposes of as outside the scope of his report. For example, in regard to the Lot (1/2 ounce) he says, "The coffee-bean volume measure--although interesting, need not be considered as sufficiently

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1/*Ibid.*, pp. 92, 177.

2/Nicholson, *op. cit.*, pp. 219, 225.

3/Kennelly, *op. cit.*, p. 123.

4/*Ibid.*, p. 179.

important to be assigned as a German non-metric unit in commercial use." Again he says, "The cases also of specific gravity and thermometer degrees lie outside the scope of this enquiry. The Whitworth screw, and screw sizes are in use. They are non-metric, but are industrial rather than commercial units. These, as well as the numbers of gloves, stockings, and shoes, all based on the English inch, are trade sizes and not trade units of measure."[1/] Also he overlooks completely the customary units of time and of the duodecimal packing system. The distinction between trade sizes and trade units is questionable. In this same category he places shirt measures, based upon the English inch and the centimeter, designating them as "mere trade numbers."[2/] To account for non-metric screw threads, he makes the following distinction, "The water and gas pipe threads and incandescent lamp threads, mentioned as exceptions, although not metric, are industrial sizes and not commercial unit measures."[3/] Of that large and very important area of customary measures used at sea he writes, "As regards the nautical mile or naut of 1.853 kilometer and its derivative, the knot....a speed of one naut per hour.... referred to in the Melchior[4/] document as a persisting submetricised unit, it should be observed that this really falls outside the scope of this report."[5/] Here again to consider a knot as any except a customary measure is open to question, in the writer's opinion.

To summarize briefly, the tabulation of the data of the Halsey questionnaire study indicated that in Brazil, Argentina, and Uruguay approximately

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1/*Ibid.*, p. 88.

2/*Ibid.*, p. 168.

3/*Ibid.*, p. 91.

4/*Ibid.*, p. 86. 1.853 kilometer (6077.84 feet).

5/*Ibid.*, p. 93.

as many customary as metric weights and measures were being used in 1919. The writer agrees, in general, with Halsey's conclusions (see pages 55-57). The tabulation of the Kennelly data, in which the metric usage was estimated, indicated that in continental Europe the use of customary weights and measures was considerably more than a quarter of the total usage in 1929. Kennelly's conclusions (see pages 63-64), therefore, in the opinion of the writer, are open to question at least, since they are definitely out of line with other studies and have specific weaknesses which have been noted in the previous discussion. The writer also cannot agree with certain statements made in the Kennelly report. Parts of this report and some of its terminology, in the writer's opinion, show evidence of bias as well as lack of scientific thoroughness.

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CHAPTER VII

THE FIELD STUDY DATA

Pages 125-135 are magnigraphs of the master-sheets on which were tabulated the data of the field work done by the writer in Brazil, Argentina, Uruguay, and Paraguay. The first column at the left gives the date; the next the place; the third the state;[1] and the fourth the country. The fifth column gives the metric units, which were actually encountered, together with the writer's estimate (the encircled numbers) of additional metric usage, when such an estimate was considered necessary. The column at the extreme right gives the customary units found in actual use, together with some estimates and notes in regard to sources of information or other interesting facts. In the lower right corner are indicated the number of times the metric and customary units were mentioned on each master-sheet, the count being taken by commodities. In this tabulation there were eleven master-sheets; four and a half for weight; three and a half for length; two for capacity; and one for surface.[2]

The method of estimating the metric usage has been described on page 82 of this dissertation, but further concrete examples will be given here. Referring to page 125, the first estimate in the metric column is for the only store at Bom Jardim, a small village on the bank of the Amazon River.

1/Brazil has 22 states.

2/The master-sheets have been prepared with the greatest care, but as many products and strange situations were involved, there is the possibility that there may be some errors.

Master-Sheet Number 1 - Yorke's Field Study

1. Date 1939	2. Place	3. State	4. Country	WEIGHT 5. Metric	6. Customary
June 23	Belem	Pará Maranhão Bahia	Brazil	Kilo - ox, cow, horse hides, pig, deer, goat, sheep skins Oil seeds Cocoa / Coffee / Sugar } in city sold by Kilo bags (132.3 lbs)	pound - leopard and snake skins - sold to Eng. and U.S. (St. Max Goodhart - Pará) arroba - Cocoa (32.4 lbs) Coffee, sugar } sold in interior (St. Eugénia Hardtmeier - Bahia) flock - sheep 20 gal. gasoline can - Cocoa (in the interior)
June 25	S.S Boniface Cargo			maize Wax (carnaúba) Kilo (Cargo from Brazil all in metric)	pound - machinery pound - automobiles (imported from U.S.) pound - flour
	Ceará	Ceará	Brazil	Kilo - 40 and 60 bags - Pará flour cotton Piassava (brooms) Cotton seeds Castor seeds nuts - Jarina (ivory) nuts (babassu) hides Potatoes (from Port.) rubber dry cattle bones (fertilizer) oiticica oil lumber - mahogany, cedar logs cocoa beans	bale - cotton (500lbs) onça - wild cat skins ton - cement, coal
June 29	São Salvador Belem	Bahia Pará	Brazil Brazil	Kilo - insecticide bundles of timbo root alumgum - rubber ton - insecticide	
June 30	Industria Vegetal Do Baixo Amazonas S.S. Belem Amazon Steam Navigation Co. - Cargo	Pará	Brazil	Kilo - 50 kilo bags mandioca (farina); coffee - salt (60k) (13)	
July 2 July 5	Bom Jardim Santarem Market	Pará, Pará	Brazil Brazil	Kilo - 60 Kilo bags - corn, rice Kilo - oranges (15)	arroba - 2 arroba baskets of sugar molha - tobacco (1 yard reed container) arroba (basket) - oranges duzia - oranges 20 gal. gasoline can - water (Colégio Jesus Maria José, Travessa dos Martyres, Delphina Amorim - Head-mistress)
				School - teach only metric	↔ but boys know customary measures - book - equivalents given.
July 7	Parintins (Japanese Colony)	Amazonas	Brazil	Kilo - rice and jute (10)	arroba - rice, maize, nuts (M. Augusta Rabout) quintal (4 arrobas) - nuts (129.5lbs) quilate - gold and precious stones (3.07grains) (5) baskets - vegetables (4)
July 8	Villa São Carlos store	Amazonas	Brazil	Kilo - coffee, rice, sugar (9) ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$)	resma - paper cacho (bunch) - bananas duzia - eggs, oranges arroba - fish - tobacco (324lbs) (St. Abraham Cohan - Traveling Salesman and others on boat.) libra (1.01 lbs.) - tobacco. onça - tobacco (fine) (1.01 oz.) - tobacco quilate (3.07grains) - gold resma - paper (500folhas) (ream - 480 Sheets)
July 8	Deposito Ze Florenci	Amazonas	Brazil	Kilo - live cattle (3) (660-880lbs) - salt (bags) - dried beef	head herd } cattle.
July 10	Manaós Loja Do Jacintho Bazar Das Novidades	Amazonas	Brazil		oitava (55.3 grains) duzia - clothes - pins cada (each) (12)
July 11	Market			100 or 50 - oranges ($\frac{1}{2}$ 100) gramma - coffee pkg. of 200 ($\frac{1}{2}$ lb. = 226.79 grams) (20) Kilo - meat ($\frac{1}{2}$) fish maize, salt sugar, cocoa mandioca	box - limes String (4 or 5 fish) Whole or $\frac{1}{2}$ fish (cada) bunch - vegetables certain number for a certain price (4 or 5 tomatoes for 100 reis = $\frac{1}{2}$¢) (3 to 5 eggs for 1 milréis = 5¢) Molha - tobacco cada - yams - turtles (a piece or quarters) slice - pumpkin
July 11 July 14	Manaós "A Tarde" (news paper) Belem Market open-air Shops	Amazonas Pará	Brazil Brazil	Kilo - deer skin gramma - gold, coffee Kilo - bread 100 - wood 100 - Oranges 250 - small oranges (20) 200 - large oranges (baskets) Kilo - guriguba (dried fish) Kilo - rice, beans, corn, farinha	pelle (skin) - rubber (2) cada - (piece) - bread - pineapple feixe - (bundle) - wood, string-beans, carrots, radishes, lattuce, scallions (not counted) acha (piece) - wood cacho (bunch) } bananas penca (small bunch) } bananas paneiro (basket) - coal - tapioca (more than 1 kilo) basket - small / medium / large } - charcoal (burlap) sack } - charcoal arroba - Sugar, tobacco, oranges Molha - tobacco

Number of Times Mentioned
Metric - 170
Customary - 96

Master-Sheet Number 2 - Yorke's Field Study

WEIGHT (continued)

1. Date 1939	2. Place	3. State	4. Country	5. Metric	6. Customary
July 14	Belem Market Shops	Pará	Brazil	kilo - fish, oranges ½ kilo - meat ½	cala - wrapping paper (17.77 lbs.) pelle - rubber (skin-sheet) handful - chairo (sweet smelling wood pulverized for sachet) certain number for a certain price (4 eggs for 1 milréis = 5¢) handful - shrimps duzia - oranges
July 15	Recife "Folha da Manhã" (newspaper)	Pernambuco	Brazil	gramma - gold	quilate - jewels (3.07 grains)
July 18	San Salvador Companahia Emporio Industrial do Norte (Textile Mill) Avenida Luiz	Bahia	Brazil	kilo - cotton (buy) (6)	arroba - cotton (buy) ton - wood (buy) bale - cotton (buy) hank - thread (buy) (2 or more skeins)
July 19	San Salvador	Bahia	Brazil		arroba (32.4 lbs.) - cocoa (Mr. Janz - Consul) See above - June 27
July 24	Rio de Janeiro Lojas Americanas Ouvidor 175-179 (5¢ to $1.00)	Rio de Janeiro	Brazil	gramma, kilo } candy ½ (100 gramma = ¼ lb) (8)	dozen, gross (144) } safety pins (imported from U.S.A., Germany, and Japan) buttons, hairnets; apiece (imported)
July 24	Rio de Janeiro Fruit Store	Rio de Janeiro	Brazil	kilo - cerejas ½ (cherries)	
July 25	Rio de Janeiro Men's Furnishing Store	Rio de Janeiro	Brazil	(6)	duzia - handkerchiefs ½, ¼
July 26	Rio de Janeiro Cia America Fabrio Rua Candelaria 17 (Cotton Mills)	Rio de Janeiro	Brazil	kilo - raw cotton	bale - cotton
July 27	Rio de Janeiro Wharves	Rio de Janeiro	Brazil	kilo - coffee (60 kilo bag) (132 lbs)	pound - bran (100 lb. bags)
July 28	Santos Coffee Exchange	São Paulo	Brazil	kilo - coffee (60 kilo bag)	
July 31	São Paulo Liceu De Artes E Oficios Avenida Tiradentes 1 (Industrial Charity School) Exhibit	São Paulo	Brazil		arroba - sugar, coffee (in the interior) Middlemen buy in old measures.
July 31	São Paulo Mercado Municipal (Municipal Market)	São Paulo	Brazil	kilo - farinha (5 kilo bag) (11.1 lbs) kilo - meat, fish (20) kilo - coffee (60 kilo bag) strawberries case of 100 - oranges (Quilo) ½ kilo - grapes tomatoes - case of 28 kilos ↔	jaca - cheese (basket - 14 to 16) (12) duzia - eggs, palmita (palm hearts) arroba - sugar, vegetables (10 arroba baskets) coda (apiece) - apples, pears, cherries arroba (basket) - tomatoes (10) cacho (bunch) - bananas - 9 duzia case (15 bags farinha) apiece - cheese
Aug. 1	Campinas Santa Elisa Fazenda (Govt Experimental Farm)	São Paulo	Brazil	kilo - coffee	arroba - cotton (sold to middlemen)
Aug 1	Campinas S.A. Industrias De Seda Nacional (silk factory)	São Paulo	Brazil	kilo - silk, cocoons gramma - eggs (5)	tonelada - silk (imported from Japan) (1814 lbs) fardo (bale) - silk and cotton (440 lbs.) cake - soap
Aug. 2	Store São Paulo Liceu De Artes E Oficios Factory	São Paulo	Brazil	kilo - (if bought in Brazil) (5)	ton - steel, brass (all metals from U.S. and England) Eng. ton (4)
Aug. 3	Rua João Theodoro, 547 São Paulo Drug Stores	São Paulo	Brazil	gramma kilo	
Aug. 3	São Paulo Mappin's Dept. Store	São Paulo	Brazil	gramma ↔	libra, onça } - balanza de familia (household weighing machine) par - gloves
Aug. 3	Rua Barão De Itapetaninga São Paulo Silk factory	São Paulo	Brazil	kilo - silk, cacoons gramma - eggs	
Aug. 3	Abrahão Andraus y Irmão, Rua da Mooca, 2100 São Paulo Casa Lemcke Rua Libero Badaro, 303	São Paulo	Brazil		duzia - handkerchiefs (men's and women's) ½
	São Paulo Foundry - Nadir Figueiredo, S.A. Avenida Independencia 901	São Paulo	Brazil	kilo - steel and tin plates, etc. (internal uses) ton - steel and tin plates, etc.	ton, pound } steel and tin plates (from U.S.)

Number of Times Mentioned
Metric - 90
Customary - 51

Master-sheet Number 3 - Yorke's Field Study

WEIGHT (continued)

1. Date 1939	2. Place	3. State	4. Country	5. Metric	6. Customary
Aug. 3	São Paulo Street Flower Stall	São Paulo	Brazil		duzia - flowers cada - flowers bunch - flowers
Aug. 3	São Paulo Fractaria Paulista Rua Anhaugabahu, 113	São Paulo	Brazil	Kilo-grapes (8)	duzia - oranges 1/2
Aug. 3	São Paulo Shops (small)	São Paulo	Brazil		1/2 duzia - socks, postcards, handkarchiefs, (men and women's)
Aug. 3	São Paulo Confermat S.A. Rua Florencio De Abreu, 3	São Paulo	Brazil	kilo-(1-10) hammer	
Aug. 3	São Paulo Lojas Americanas Rua Direita, 151-159 (5¢ to $1)	São Paulo	Brazil	kilo - candy grammo - candy (100 g. = 1/4 lb.) (12)	gross cada (apiece) par - socks (pair) (15)
Aug. 3	São Paulo Fruit and Grocery Store	São Paulo	Brazil	(16)	duzia - eggs, avacados.
Aug. 11	Asunción University of Asunción Facultad de Ciencias Economicas (Dr. Victor Riquelme Director)		Paraguay	Kilo (1/2, 1/4, 1/8, 1/16) (20)	ducena - eggs, fruit arroba (25.32 lbs) - fruit, maize, potatoes tonelada (2222.2 lbs.)
Aug. 14	Asunción U.S. Consulate (Sr. Guttman)		Paraguay	Kilo - oil of petitgrain (perfume base)	case - 8 tins of 5K. (15)
Aug. 15	Asunción Colegio International (Sr. Hughes)		Paraguay		"In Paraguay the people use the terminology of weights and measures, but in actual bargaining they use them little."
Aug. 15	Asunción Market		Paraguay	Kilo-meat fish (10)	Market
Aug. 16	Asunción Algodones S.A. (Societe Anomina) Cotton Co. Calle Presidente Franco (Sr. Root)		Paraguay	Kilo - cotton (quotations)	arroba - cotton "People talk in arrobas and think about the price in arrobas. There has been little change really."
Aug. 16	Asunción Segundo Ybarra Calle Buenos Aires, 377		Paraguay	Kilo - yerba maté (1/2, 1, 2 1/2) gramme (bags of 100) 1/4 lb.	no weight given on pkg. (12)
Aug. 16	Asunción Ocampos Y Claro (Tobacco Merchants) Calle Benjamin Constant, 376		Paraguay	Kilo-tobacco (buy)	arroba - corn, fruit, truck garden produce almude - honey (35.5 lb)
Aug. 17	Rio Paraguay S.S. General Alvear - Cia Argentina de Navegacion Mihanovich Lda.		Paraguay		mano (handful) - in the interior arroba (60 ears of shelled corn) Vardo (bundle) - thatching grass (Sr. Alan D. Menuir - lived in Paraguay many years.)
Nov. 19			Paraguay		Man's weight, child's weight } Guarani, Caingué, Guayaquies, and Chaco (Macá, Lengua, etc) tribes of Indians. (Dr. F. G. Weiss - letter)
Aug. 21	Buenos Aires Abasto Market		Argentina	Kilo (1/2, 1/4) meat, fish (20)	dozanda - eggs, vegetables (6)
Aug. 21	Buenos Aires Small Shops		Argentina	Kilo (1/4) - candy (18)	
Aug. 22	Buenos Aires Confiteria Y Panaderia De Manuel Rivas Pastry and Bakery Calle Callao, 1631		Argentina	Kilo (1/2) - candy, cake (11)	
Aug. 24	Buenos Aires U.S. Consulate Diagonal, 567 (Mr. Randall)		Argentina	quintal (220 lbs.) (20) crate - apples ↔ 100 ton (2200 lbs.) (25) hides (horse, etc.) (5)	ton - cotton, wool, casein (skimmed milk), horsehair, tallow bale - cotton and wool, goat skins, bran (550 lbs.) onza (1.01 oz.) libra (1.01 lb.) (7) docena - eggs and fruit
Aug. 24	Buenos Aires Shops Calle Bolivar		Argentina	(5)	docena - huevos (eggs)
Aug. 24	Buenos Aires La Martona Calle Bolivar, 190		Argentina		docena - pencils, postcards

Number of Times Mentioned
Metric - 205
Customary - 100

Master-Sheet Number 4 - Yorke's Field Study

1. Date 1939	2. Place	3. State	4. Country	WEIGHT (continued) 5. Metric	6. Customary
Aug. 24	Buenos Aires Cristalerias Rigolleau (glass factory) Paseo Colón, 800		Argentina	Kilo (9)	pound - marmalade jars (1 and 2) (5) tonelada - sand and raw materials (0.904 ton)
Aug. 25	Buenos Aires M.S. Bagley Cia Ltda. Avenida Montes de Oca, 199 (Biscuit Manufacturing Co.)		Argentina	Kilo (10) (3) ton - wheat - grains quintal	pound libra - tea (sell) - jam - marmalade (1 or 2) ton - paper, coal (imported)
Aug. 25	Buenos Aires Saint Hermanos Herrera, 855 (El Aguila chocolates)		Argentina	Kilo (declared in customs) (9) convert formulas (call Kilos unless you have ounces)	pound - chocolate beans from Trinidad and Ceylon - price quotation.
Aug. 25	Buenos Aires Sociedad Anonima Fábrica Argentina De Alpargatas (jute soled shoe with canvas upper) Patricios, 1153 Mr. W. E. Stuart Heath (textile factory)		Argentina	(6)	fardo - cotton (bale) ton - jute, sisal } imported from Calcutta
Aug. 25	Buenos Aires Instituto Biológico Argentino Rivadavia, 1745 (drugs)		Argentina	(8)	Troy, Apothecaries', Avoirdupois } weights (20) ounce pound
Aug. 25	Buenos Aires Bakery Shop		Argentina	Kilo (¼) - rolls, sweet crackers	
Aug. 28	Montevideo U.S. Consulate Sr. Tomas Zafiriadis		Uruguay	Kilo - hides (in small quantities) (10)	apiece (each) - hide bale (550 lb.) - Wool (no standard - vary 50 kilos) pound - meat (exported)
Aug. 28	Montevideo Bazar Dos Mundos (novelty store) Calle Sarandi, 159		Uruguay	(8)	ton - coal (imported from England)
Aug. 29	Montevideo Frigorifico National Solis, 1480 (meat packing)		Uruguay	Kilo - live meat (stock yard) (14)	pound - meat (exported to the United States and England) pound - fertilizers, salted hides, pickled lamb, skins, cornbeef, salted beef (exported everywhere in pounds even to Europe)
Aug. 31	Montevideo Ancap 25 de Mayo, 409 Sr. Garcia (industrial Co.)		Uruguay	Kilo - maize, cement (bag) (15) ton (1000 K) (2200 lbs.) - coal, coke (imported from Eng. and Germany)	
Aug. 30	Montevideo Ancap (Administración Nacional de Combustibles, Alcohol y Portland) 25 de Mayo, 409. Sr. Garcia		Uruguay	Kilo - carbon dioxide, maize oil, barley, corn cakes	ton (long) (2240 lbs.) (charter tankers - oil 9-15000 capacity) (3)
Aug. 31	Montevideo Castiglioni and Lucas - Calcraft Calle Buenos Aires, 430 (importers)		Uruguay	Kilo - yerba maté	apiece - hides pound - hides paquete - tea, cocoa, dates, Jell-O, apples, raisins, Post Toasties (manzanas) Grape Nuts, tapioca pound - tea cajón (case) - 40 paquetes, 50 latas, 24 paquetes, oranges (from California) - 48 latas lata (tin) - wafers, cane sugar syrup, baking powder, postum (grande chica) sardines, tea (¼) tanque (large can) olive oil tableta (bar) milk chocolate caja (box) - dates, Grape Nuts, seedless raisins, cake flour, bran, salt, shredded wheat fardo (bale) - fibra de coco (for mattresses) porrone (jug) - ginebra - imported from Holland.

Number of Times Mentioned
Metric - 110
Customary - 81

Master-Sheet Number 5 - Torke's Field Study

WEIGHT (continued)

1. Date	2. Place	3. State	4. Country	5. Metric	6. Customary
1939 Aug 30	Montevideo Castiglioni and Lucas - Calcraft (continued)		Uruguay		pastilla - coco (lozenge) ja bone - coco (bar) jabón - coco (cake) barra - coco (bar) Saco - walnuts - imported from California - pecans docena - tins of baking powder, tennis balls, frascos of relish, botella of vinegar (½)
Aug 30	Montevideo Augusto Wild 25 de Mayo, 667		Uruguay	carat (3.09 grams) (15) diamonds - imported from Belgium, Holland, and South Africa - jewels	arroba (25.32 lbs.)
Aug 30	Montevideo Fabrica Uruguaya de Alpargatas S.A. Isidoro de Maria, 1631 (shoes)		Uruguay	Kilo - hemp (10) (imported from Italy) sole leather	pound - wool bale - jute, wool, cotton yarn
Aug 30	Montevideo Mercado Municipal (Central Market)		Uruguay	(25)	docena - oranges, apples, artichokes
Sept 1	Buenos Aires Herald (newspaper)		Argentina	ton - lindseed, maize, sunflower, cotton-seed, cotton - cakes Kilo (½ = ½ lb) flour, rye, steers, wethers, ewes, lambs, capones, cotton, wheat, oats, barley gramme - butter, oil (30g. = 1 ounce) ¾ - pe jerrey (fish) (28.35g.) (200g. = ½ pound) wrappers (40g. = 1½ ounce) (10)	table spoon (½) - sugar, butter, bread crumbs, salt, pepper, flour cup (½) - cream, broth, wine pound (½) - tea, sugar, rubber, cotton, oats, lindseed (2) pinch - salt ton - ships from Norway, England, Yugoslavia, Italy, United States, Finland, Japan ounce - sliver hundred weight - sugar cental (1/20 ton or 100 pounds) - wheat, maize
Nov 19	Buenos Aires Dr. F. G. Weiss (letter)		Argentina		pesada de cueros secos (35 libras = 35.45 pounds) - dry hides pesada de cueros salados (60 libras = 60.77 pounds) - salted hides pesada de cueros carneros lav. (30 libras = 30.38 pounds) - washed sheepskins
Sept 4	Santos Market	São Paulo	Brazil	(17)	duzia - eggs (5)
Sept 4	Santos Store	São Paulo	Brazil	Kilo - grapes (11)	duzia (½) - nectarines, fruit (9) cada (each) - apples, pears
Sept 5	Santos U.S. Consulate Mr. Parslee	São Paulo	Brazil	Kilo - coffee (bag of 60) (15) 132 lbs.	arroba - sugar (32.4 lbs.) ½ (coffee / cereals in interior) cacho (bunch - 9 doz.) - bananas

LENGTH

Date 1939	Place	State	Country	Metric	Customary
June 21	Belem	Pará Maranhão Bahia	Brazil	hides - conversion tables used	inch - hides (horse, ox, cow), skins (pig, sheep, deer, goat), reptile skins - sold to the United States and England (Sr. Max Goodhart) legua (2.3 mi.) - interior (Sr. Eugenio Hardtmeier) pollegada (1.1 inches) - building (thickness of walls) foot - barbed and plain wire fencing (from the United States and England) inch - machinery, automobiles, frigidaires
June 28	S.S. Boniface Cargo	Pará	Brazil		
June 21	Belem Industria Vegetal Do Baixo Amazonas M. Fornier	Pará	Brazil	metro - mortgages (13)	palmo / pollegada - timber
July 2	Floresta and all along the Amazon River - stopped once a day for wood	Pará Amazonas	Brazil Brazil	metro - cloth (20)	piece - lace - (Woman measured from nose. Said piece was 4 metros - was actually 13 yards - Fortaleza, Ceará. Same done at Maceió, Alagoas. Mrs. de Gruchy) palmo (9 in.) - wood (fuel for boat - 4 palmos long) (10) braca - navigation - depth of water (M. Auguste Rabout) (arm - 1.9 yd. = 6 ft.) pé - navigation - depth of water - wood (foot - 13 in.) pollegada - building (1.1 in.)
July 5	Santarem	Pará	Brazil	centimetro - lace metro - cloth (5)	piece - lace
July 9	Villa São Carlos	Amazonas	Brazil	metro - cloth	milha - place to place (1.3 miles) legua (2.3 mi) (Sr. Abraham Cohen - traveling salesman and others.) milha - distance (1.3 mi) braça (1.9 yd) - rope pé - iron (13 in.) braça - rope palmo - wood (9 in.) pollegada (1.1 in.) - iron
July 10	Manáos A Tarde (newspaper)	Amazonas	Brazil	metro - cloth (14)	
July 14	Belem Casa Crocodilo	Pará	Brazil	centimetro - belts (1)	pollegada - belts
July 15	Recife Folha da Manhã (newspaper)	Pernambuco	Brazil	metro - racing	

Number of Times mentioned
Metric - 212
Customary - 112

Master-Sheet Number 6 - Yorke's Field Study

LENGTH (continued)

1. Date 1939	2. Place	3. State	4. Country	5. Metric	6. Customary
July 18	San Salvador Companahia Emporio Industrial do Norte (Textile Mill) Avenida Luiz	Bahia	Brazil	metro (folding machine everything sold in metros (12) centimetro (2 German engines)	Yard - measuring threads beaming machine (winds warp upon the warping beam of a loom.) inch - machinery (more English and United States' than German - looms (cloth) spinning and winding frames England U.S.A.
July 18	San Salvador Mobiliaria (Woodworking) Factory Rua Dr. Seabra	Bahia	Brazil	centimetro - furniture metro (5) centimetro - machinery and tools (German and Belgian)	pollegada (1.1 in.) - furniture palmo (9 in.) pé (13 in.) inch - machinery and tools (Eng. and U.S.A.)
July 25	Rio de Janeiro (Dressmaker)	Rio de Janeiro	Brazil	centimetro metro (½)	-
July 24	Rio de Janeiro José Trotta Tailor Rua 7 Setembro, 19	Rio de Janeiro	Brazil	centimetro (making suit) metro - cloth (½)	yard - cloth (imports British - 3 yds for a suit)
July 24	Rio de Janeiro Lojas Americanas Ouvidor 175-179 (5¢ to $1)	Rio de Janeiro	Brazil	metro - ribbon, lace, cloth (½) (10)	yard - imported cloth inch - dress patterns (U.S.A. sizes - measurements in metric converted into U.S.A. sizes)
July 24	Rio de Janeiro Cia America Fabril Rua Candelaria 67 (Cotton Mills)	Rio de Janeiro	Brazil	metro - cloth measuring machine (6)	inch - machinery (U.S.A. and Eng.)
July 31	São Paulo Liceu De Artes E Oficios Avenida Tiradentes, 1 (Industrial Charity School Exhibit)	São Paulo	Brazil	(9)	pollegada (1.1 in) - iron palmo (9 in) - wood braça (1.9 yd.) - wood inch (½, ¼, ⅛, 1/10, 1/32, 1/64, 1/100, 1/1000)
Aug. 1	Vallinhos	São Paulo	Brazil	kilometro metro (altitude)	
Aug. 1	Campinas S.A. Industrias De Seda Nacional (silk factory)	São Paulo	Brazil	centimetro machinery (Italian) (8)	bracia (bacinella) (skein) - silk (sell) meada - silk thread (sell) (skein) inch - machines (U.S.A. winding)
Aug. 2	São Paulo Liceu De Artes E Oficios (Industrial Charity School) Factory Rua João Theodoro, 547	São Paulo	Brazil	centimetro - machinery - German - two tables - millimetro, centimetro, inch ↔ gears in inch and ↔ centimetro centimetro ↔ screws tools micrometers drafting (10)	inch - machines (machine shop and in all departments) (Eng. and U.S.A change gear for metric to make screws) (10) inch - rules
Aug. 3	São Paulo Abrahão Andraus Irmão (Silk Factory) Rua da Mooca, 2100	São Paulo	Brazil	metro - silk, rayon, yarn (7) (imports animal silk yarn from Japan and Italy) centimetro metro machines	(Sr. Zeno Barbosa - U.S. Consulate)
Aug. 3	São Paulo Nadir Figueiredo S.A. Avenida Independencia, 70 (Foundry)	São Paulo	Brazil	centimetro - machines metro (internal use) all metric (5)	
Aug. 3	São Paulo Lojas Americanas Rua Direita, 151-159 (5¢ to $1)	São Paulo	Brazil	metro - cloth (7) ribbon (sell) lace	yard - imported cloth
Aug. 3	São Paulo Confermot S/A Rua Florencio De Abreu, 3 (Iron and building materials <u>French Company</u>)	São Paulo	Brazil	centimetro — metro (30) centimetro ↔	inch, foot, yard } steel tape, folding foot rule (30) inch - drills (<u>imported from France</u>) - tools - machines
Aug. 11	Asunción University of Asunción Facultad de Ciencias Economicas (Dr. Victor Riquelme) Director		Paraguay	metro - land deeds (5)	vara (land deeds) (2.84 ft.) legua (2.4 mi.) braza - navigation (5.68 ft.)
Aug. 11	Asunción Dr. Eugenio Codas Banco Agricola Calle Palma, 182		Paraguay	metro ↔ (7)	pulgada - steel tape (0.96 in.) pulgada - wood
Aug. 14	Asunción U.S. Consulate Deed of land #345 June 24, 1931.		Paraguay	metro, millimetro } land (5)	pié - land (0.95 ft.) pulgada, centivara } land (2.84 ft.)

Number of Times Mentioned
Metric - 172
Customary - 80

Master-sheet Number 7 - Yorke's Field Study

LENGTH (continued)

1. Date 1939	2. Place	3. State	4. Country	5. Metric	6. Customary
Aug 14	Asunción (continued) Sr. Guttman at U S Consulate		Paraguay		foot - land inch - land legua - land (3.22 miles) (cattle, lumber or yerba mate estates) quebrácho
Aug. 16	Asunción Ocampos Y claro Calle Benjamin Constant, 376 (Tobacco merchants)		Paraguay	board metro - lumber (9) (1 in. thick, 1 foot wide, 1 metro long) metro x pulgada x pulgada	pulgada - lumber vara (34 in.) land (old deeds) pulgada - land (old deeds) legua - land (old deeds) board - foot - lumber
Aug 16	Asunción segundo Ybarra calle Buenos Aires, 377		Paraguay		
Aug 17	Rio Paraguay S.S. General Alvear Cia Argentina de Navegacion Mihanovich Lda.		Paraguay	(6)	pié (0.95 ft.) - sounding braza - sounding (5.68 ft.)
Nov. 19	Dr. F. G. Weiss (letter)		Paraguay		day's trip - Guarani, Cainguá, Guayaquies, and chaco (Macá, Langua, etc.) tribes of Indians
Aug 18	S.S. General Alvear (Senora Lusarreta Posados)		Argentina	(5)	legua - (3.1 mi.) (distance from)
Aug 18	Rio Parana		Argentina		pie (0.95 ft.) } sounding braza (5.68 ft.) } sounding
Aug 22	Buenos Aires Harrods Ltd. Dept. Store Florida, 877		Argentina	(15)	pulgada - haircut (0.96 in.)
Aug 24	Buenos Aires U.S. consulate Diagonal, 567 Mr. Randall had made a recent study - get law changed - use either system.		Argentina	metro - steel tape (now only) (10) centimetro ↔ (no more rulers to be sold with double measures)	inch } foot } - automotive industry (U.S. measures) - repair shops rebore cylinders - use inch calibers inch - tools } machinery } calibrated to inch if of U.S. or Eng. origin pulgada - lumber (always) board foot (1 ft. square X 1 inch thick) - log (buy 1000 board feet) inch - screw threads bolts (#32 = 32 threads to an inch) gages vara - (2.84 ft. - land deeds legua - (used on farms) inch - rulers (still on the market as law is not strictly enforced)
Aug 24	Buenos Aires Cristalerias Rigolleau (glass factory) Paseo Colón, 800		Argentina	centimetro machinery (German) (7)	inch - machinery (U.S and Eng. - order by number - do not specify metric)
Aug 24	Buenos Aires Compania de Electricidad Balcarce, 184		Argentina	centimetro (drafting) ↔ bridge contract U.S. steel bid in U.S. system, but gov't made them convert into metric (10)	inch - machinery (U.S and Eng.) pipes bolts railroads - locomotives wagons bridges
Aug 25	Buenos Aires M.S. Bagley cia Ltda. Avenida Montes de Oca, 199 (Biscuit Manufacturing Co.)		Argentina	centigrade ↔ (7)	inch - machinery (biscuit) Fahrenheit - thermometer Fahrenheit
Aug 25	Buenos Aires Saint Hermanos (El Aguila chocolates) Mr. Burcham Mr. Kennedy		Argentina	centimetro metro - building (10)	inch - machinery - ice. cream (from U.S.A.) bon bons (from U.S.A., Eng. and Germany) inch - screws
Aug 25	Buenos Aires Sociedad Anonima Fábrica Argentina De Alpargatas Patricios, 1053 Mr. W. E. S. Heath (textile factory)		Argentina	metro - canvas rope centimetro designing (9)	inch - machinery - U.S. United Shoe Eng.

Number of Times Mentioned
Metric - 99
Customary - 55

Master-sheet Number 8 - Yorke's Field Study

LENGTH (continued)

1. Date 1939	2. Place	3. State	4. Country	5. Metric	6. Customary
Aug. 25	Buenos Aires Alberto Grimoldi Rivadavia, 2840 (shoe factory)		Argentina	centimetro (½) shoe sizes (½) 3	inch - shoe sizes (4 full sizes) common foot - hides (buy) (leather)
Aug. 25	Buenos Aires Sociedad Industrial Americana de Maquinaria Avenida de Mayo, 1302 (manufacture machinery)		Argentina	centimetro - refrigerators, designs 6	inch - {threads (machinery) {sheet metal
Aug. 24	Buenos Aires Senor Aldo Banchero Yerbal, 49 Public School Inspector		Argentina	Teach both systems in the Argentine schools.	
Aug. 28	Montevideo London - Paris (Dept. Store) Avenida 18 de Julio and Calle Rió Negro		Uruguay	metre - cloth (½, ¼, ¾, ⅛, 1/16) centimetre - cloth 6 centimetre - collars (35 to 44)	size - gloves (5¾ to 7¾) - made in Uruguay imported from France (6 - 7¾) Italy Belgium Eng. size - socks (men's - 8½ to 10) yard - silk (imported from U.S., Eng., and Japan)
Aug. 28	Montevideo Bazar Dos Mundos (novelty store) Calle Sarandi, 150		Uruguay	(new deeds in metric, but if land not sold before, use original measurements) 8 sq. metre → x 10	vara - land (old deeds) (0.95 yd.) legua - distance in the country - estancia (ranch) (3.23 mi.) cuadra - distance in the country - estancia (ranch) (100 or 150 varas (94.66 or 141.99 yds.) (284.13 or 426.18 ft.) board foot - lumber (12 in. x 12 in. x 1 in.) EX. $\frac{1 \times 12 \times 18}{12}$ feet long = 18 sq. ft. (impossible in metric) pié (0.95 ft.) } navigation braza (5.68 ft.) } navigation knot } navigation (nautical mile = 2025 yds. = 6075 ft.)
Aug. 29	Montevideo Kosmos Papeleria Imprenta Lagomarsino Hermanos (Bros) Calle Santi Sarandi, 427 (Printers)		Uruguay	Centigrada ↔ 5	Fahrenheit - thermometer (outdoor)
Aug. 30	Montevideo Ancap (Administración Nacional de Combustibles, Alcohol y Portland) 25 de Mayo, 409 Senor Garcia		Uruguay	centigrada ↔ alcohol (potable) laboratory equipment (imported from U.S.) → 6	Fahrenheit - thermometer used most Refer to U.S. and Eng. systems
Aug. 30	Montevideo Papeleria Galli Calle Rincon, 549		Uruguay	centigrada ↔ 5	Fahrenheit - thermometer (outdoor)
Aug. 30	Montevideo Pablo Ferrando Calle Sarandi, 675 (optical, photographic, hospital supplies)		Uruguay	dioptric (unit for expressing the refractive power of a lens whose focal distance is one metre) Centigrada ↔ Centimetre - photographic and hospital supplies. 15	Fahrenheit - thermometers (have both scales)
Aug. 30	Montevideo Linn and Cia. Calle Galicia, 1041 (general importers)		Uruguay	15	inch } foot } automobiles, tires, plows, dentist chairs, screw threads (#16 = 16 threads to an inch), machinery - permanent wave, windmills (#8 = 8 feet), towers, typewriters.
Aug. 30	Montevideo Campomar y Soulas Calle Uruguay, 973 (textiles)		Uruguay	metre - woolen and cotton goods 6	inch - machinery (imported from Eng.)

Number of Times Mentioned
Metric - 93
Customary - 50

Master-sheet Number 9 - Yorke's Field Study

LENGTH (continued)

1. Date	2. Place	3. State	4. Country	5. Metric	6. Customary
1939 Aug 30	Montevideo Fabrica Uruguaya de Alpargatas, S.A. Isidoro de Maria, 1631 (Shoes)		Uruguay	metre - canvas duck, drilling, cotton cloth (10) centimetre machines adjusted	foot - wood inch - Machines (U.S. and Eng.) winding, weaving
Sept. 1	Buenos Aires Herald (newspaper) ads.		Argentina	centigrade temperature report metro (racing), land centimetro - land	vara - land size (24 - 38) Windjammers years (6-14) - trousers
Sept. 5	Santos U.S. Consulate	São Paulo	Brazil	(25)	legua braça - land, cords, cables (½ vara) Vara - land palmo - wood, snakes

CAPACITY

Date	Place	State	Country	Metric	Customary
1939 June 14	S.S. Boniface Booth Line		Brazil	litro (1.1 qt.) - crude oil	gallon - 5 gal. cans - aviation gasolene - marked in U.S. measures - 2 cans in wooden case - sold all over S.A. - no other refined oil in S.A. hogshead - wine (63 gal.), Claret (46 gal.), Port (57 gal.) Sherry (54 gal.), Madeira (46 gal.) gallon - crude oil sent to U.S marked in both gal. and litro
June 29 June 30	Belem Industria Vegetal D. Baiga S.S. Belem Amazon Steam Navigation Co.	Pará Pará	Brazil Brazil	litro - mineral water (Caxambú) (5) (5) ½	pipa - (111.8 gal.) - Wine (10) arroba (1 bu.) - Vegetables, fruit (in the interior) quarta - (¼ bu.) - Vegetables, fruit (in the interior) gallon - barrels of 53 gal. - motor gasolene barril (55 gal.) - Texaco petroleum
July 5 July 9	Santarem Villa São Carlos Store	Pará Amazonas	Brazil	(6)	gallon - 20 gal. cans - water alqueire - farinha (yellow and white) (1.1 bu.)
July 10	Manáos	Amazonas	Brazil	(10)	quarta - farinha (8 qt. = 1 pk. = ¼ bu. = ¼ alqueire) (Sr. Abraham Cohen - traveling salesman and others on boat.) pipa - gasolene (111.8 gal.)
July 12	Manáos Market	Amazonas	Brazil	litro (1.1 qt.) rice, beans, starch (¼) (9)	bottle - African oil 5 gal. cans - tucupy (cooking oil) alqueire (basket) - farina
July 14	Belem Market open-air	Pará	Brazil	litro - honey (jar of 3 litros) (12)	alqueire - assahy berries - macacheira (root used as potato) (1 and ½ baskets) ¼ alqueire cuia - gourd paneiro (basket - cará (root used as a vegetable) (½ alqueire) alquiere (2.15 gal.) - farina dagua (flour of water) (½. ¼) alquiere - tomatoes (⅛) quarta - tapioca, batata doce (sweet potato) (½. ⅛)
July 18	San Salvador Mobiliaria (Wood working Factory) Rua Dr. Seabra	Bahia	Brazil	cubic metro - wood (4)	
July 21	Rio de Janeiro street vendor	Rio de Janeiro	Brazil	litro - milk (½. ¼) (3)	
Aug. 2	São Paulo Liceu De Artes E Oficios (Industrial Charity School) Exhibit Factory Rua João Theodoro, 547	São Paulo	Brazil	cubic metro wood (in the interior) (5)	gallon } oil and pint } paints
Aug. 11	Asunción University of Asunción Facultad de Ciencias Economicas Dr. Victor Riquelme, Director		Paraguay	(14)	galón - oil (imported from Spain) (6.69 pints) wine (imported from U.S.A. and Eng.) cuarta (1.05 pints) onza - drugs (1.02 oz.) baril (20.08 gal.)
	Dr. Eugenio Codas Banco Agricola Calle Palma, 182			(5)	azumbre - honey (0.53 gal.)
Aug. 16	Asunción Ocampos Y Claro Calle Benjamin Constant, 376 (Tobacco merchants)		Paraguay	metre cubique logs (7)	Vara cúbica - lumber (1 yd. by 10 in.) yarda cúbica - logs (1 yd. by 10 in.)
Aug. 17	Rio Paraguay S.S. General Alvear Cia Argentina de Navegacion Mihanovich Lda.		Paraguay	(12)	Cattle-hide - full - treacle (Sr. Alan D. Menmuir - lived in Paraguay many years.)

Number of Times Mentioned
Metric - 147
Customary - 68

Master-sheet Number 10 - Yorke's Field Study

CAPACITY (continued)

1. Date	2. Place	3. State	4. Country	5. Metric	6. Customary
1939 Nov. 19			Paraguay		almuda (1/3 bu.) - salt, grains (Dr. F. G. Weiss - letter)
Aug. 24	Buenos Aires U.S. Consulate Diagonal, 567 Mr. Randall		Argentina	litre - milk (16)	galón (translation)
Aug. 24	Buenos Aires Compañia Argentina de Electricidad Bo carce, 184		Argentina	horsepower (0.986) (736 watts) (75 Kilogram meter per sec.) (5)	Kilowatt
Aug. 25	Buenos Aires grocery store		Argentina	litre - olive oil (1½, 2½)	
Aug. 25	Buenos Aires Instituto Biológico Argentino Rivadavia, 1745 (drugs)		Argentina		dry liquid } measure (20) pint gallon quart
Aug. 28	Montevideo London - Paris (Dept. store) Avenida 18 de Julio y Calle Rió Negro		Uruguay	(5)	bottle - perfume (imported)
Aug. 28	Montevideo Bazar Dos Mundos (novelty store) Calle Sarandi, 650		Uruguay	(6)	galón - oil (imported from U.S.A.) pipa - wine - distilleries (102.37 gal.)
Aug. 30	Montevideo Ancap (Administración Nacional de Combustibles Alcohol y Portland) 25 de Mayo, 409 Sr. Garcia		Uruguay	litre - molasses, wine, gasoline, kerosene, gas, oil, fuel oil, alcohol (10) cubic metre - gas, crude oil, (refined) litre - gas pumps collories per cubic metre - gas (0.1125 British thermal unit) per cubic foot	gallon - oil (refined and crude) (imported from U.S.A.) - crude oil (imported from Ecuador, Venezuela, Curaçao, Mexico) barrel - crude oil (quotations from Venezuela, Curaçao, Mexico) (42 gal.) dram - alcohol (imported from Holland) certain quantity for a certain price
Aug. 30	Montevideo Caballo Blanco Bar Calle Sarandi, 489		Uruguay		botella - Buchanan's Black and White Whiskey (imported) gin (sell)
Aug. 29	Montevideo Castiglioni and Lucas-Colcraft Calle Buenos Aires 430 (importers)		Uruguay	(13)	botella - liquids (imported from U.S.A. and Eng.) (sell) (full-sized, ½, ¼) - vinegar, Port, Vermouth, Angostura Bitters lata - olive oil, coffee (Sanka) (tin or can) cajón - 12 botellas, 20 latas, docena frascos, 24 (case) frasco - relish, vanilla (0.54 gal.)
Sept. 1	Buenos Aires Herald (newspaper)		Argentina		bushel - linseed, maize, oats, rye
Nov. 19			Argentina		cuarta (Dr. E. G. Weiss - letter) (1.1 pint) frasco (0.54 gal.) galón (0.84 gal.) baril (16.73 gal.) cuartilla (0.95 bu.) fanega (3.77 bu.)
Sept. 5	Santos U.S. Consulate	São Paulo	Brazil	(6)	pipa (126.4 gal.) Tonel (252.9 gal.) quartola (63.2 gal.) barril } Wine barrica - beer, mate (small barrel)

Number of Times Mentioned
Metric - 78
Customary - 76

Master-sheet Number 11 - Yorke's Field Study

SURFACE

1. Date 1939	2. Place	3. State	4. Country	5. Metric	6. Customary
June 29	Balem Industria Vegetal Do Baixo Amazonas M. Fornier	Pará	Brazil	Mortgages (3) are - land hectare - land square metro - land square Kilometro - land	alqueire Paulista (6 acres) (Sr. Max Goedhart) quadra (square) sismaria - cattle-breeding land (217½ acres) leguaquadrada - land (10.24 sq. mi.)
July 15	Recife Folha da Manhã (newspaper)	Pernambuco	Brazil	metro quadrado	
July 18	São Salvador Companahia Emporio Industrial do Norte. Mobiliaria (Wood working factory) Rua Dr Seabra	Bahia	Brazil	Square metro - land, logs (sawed) (3)	
July 31	São Paulo Liceu De Artes E Oficios Avenida Tiradentes (Industrial Charity School) Exhibit	São Paulo	Brazil	Square metro - Wood (6)	
Aug. 3	São Paulo O Estado De São Paulo (newspaper)	São Paulo	Brazil	(10)	alqueire Paulista - farm land (6 acres)
Aug. 3	São Paulo	São Paulo	Brazil	Square metro (Sr. Zeno Barbosa U.S.A. Consulate)	
Aug. 14	Asunción U.S. Consulate - Deed of land # 345, June 24, 1931.		Paraguay	Square metre square decimetre land (5)	Mensura Judicial (If properties are imperfectly surveyed, the Judge summons all persons holding adjacent properties, and announces property's limits according to seller. If anyone protests, the Judge investigates, and delimits the property.)
Aug. 14	Asunción Ocampos Y Claro Calle Benjamin Constant, 376 (tobacco merchants)		Paraguay		Square inch - lumber
Nov. 19			Paraguay		liño - land (Dr. F. G. Weiss - letter) (900 sq. yds.)
Aug. 25	Buenos Aires Sociedad Anonima Fábrica Argentina De Alpargatas (jute soled shoe with canvas upper) Patricios, 1053 Mr. W. E. Stuart Heath (textile factory)		Argentina	Square metre - Machines for measuring leather (3)	
Aug. 30	Monte Video Fabrica Uruguaya de Alpargatas S.A. Isidoro de Maria 1631 (shoes)		Uruguay	Square metre leather for uppers (5)	
Sept. 1	Buenos Aires Herald (newspaper)		Argentina	Square metre - land	Square vara - land (8.07 sq. ft.)
Sept. 5	Santos U.S. Consulate	São Paulo	Brazil	hectare (7)	alqueire Paulista - land (6 acres)

Number of Times Mentioned
Metric - 58
Customary - 9

Maize (corn) and rice were especially noted as being sold by the kilo, but, as the boat made only a short stop, it was necessary to estimate the other commodities, which were sold by metric units. Obviously such a store would carry only the barest necessities such as: meat, salt, farinha, beans, sugar, and coffee. Judging from other similar stores meat would be sold by the kilo and 1/2, 1/4, 1/8 kilo; salt, farinha, beans, and sugar by the kilo; while coffee would be sold not only by the kilo and 1/2, 1/4, 1/8 kilo, but by the grammo, thus making the total estimate 13.

From the tabulation of the eleven master-sheets it was found that customary weights and measures were mentioned 778 times, while the estimate for metric units was 1,434. This gave a percentage of 35% for customary usage and 65% for metric.

Typical Findings

Before attempting to draw any conclusions from the data of this field study, the writer will discuss some of the findings in detail. It should be pointed out first that, in general, the use of metric units is disregarded to a great extent in the interior, whereas in the cities the laws are more strictly enforced, and therefore are evaded. For instance, along the Amazon River it was found that two commodities which the natives sell in quantity, sugar and wood, are weighed and measured by customary units--sugar by the arroba (32.47 pounds)[1] and wood by the palmo (8.66 inches). As may be seen from the photographs,[2] which the writer took, the sugar is shipped in baskets weighing two arrobas (65 pounds) and the wood, which is used by the river boat is cut into lengths of four palmos (34.8 inches). Also the

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1/A bushel of oats weighs 32 pounds.

2/See Appendix F, pp. 300-301.

principal cargo, gasoline and petroleum, destined for Manáos, is shipped in barrels, labeled 53 gallons and 55 gallons respectively. Nuts along the river are sold by the quintal [1] (129.88 pounds), and arroba (32.47 pounds), while rice, corn, fish, and tobacco are also sold by the latter unit. At Santarém, a town five hundred miles up the river, oranges are sold by the arroba, the quintal, and the duzia (dozen), and the writer found here a waterman using a twenty gallon gasoline can for a measure. He was selling a can of water for 100 réis (1/2 cent). [2] In this connection Señor Hardtmeier, an exporter, reported that he, too, had seen such cans used as measures for cocoa in the interior near Bahia, and that the arroba is used there also for weighing cocoa, coffee, and sugar. The United States Consul at Bahia corroborated this statement in regard to the use of the arroba for weighing cocoa, while the Vice Consul at Santos stated, likewise, that the arroba and half arroba are used in the nearby interior for coffee, sugar, salt pork, and cereals. The general store in Villa São Carlos, a village on the banks of the Amazon, sells farinha by the alqueire (1.03 bushel) and quarta (1.03 peck); tobacco by the libra (1.01 pound) and onça (1.01 ounce); and eggs and oranges by the duzia (dozen). Here distance is measured by the milha (1.37 mile) and legua (4.09 miles), the writer was informed. A fellow traveler reported that, when buying lace in Fortaleza, Ceará, and in Maceió, Alagôas, she had seen the native women measure lengths from the end of the nose to the fingertips. They also sell by the piece. One piece, which the lace-maker said contained four metros (4.38 yards), actually was thirteen yards long, indicating that this Brazilian woman did not comprehend even the approximate length of a metro.

1/There are 4 arrobas in a quintal.

2/See Appendix F, p. 302.

Likewise in Paraguay, which is in the interior, a thousand miles up the Rio Plata, the people use metric weights and measures very little in actual bargaining even though they may use metric terminology. Furthermore most of the domestic trade is carried on by barter. As in Amazonas, Brazil, the people, if they have any money, are so poor in general that they buy in very small quantities. Mr. Root, head of one of the largest cotton firms in Paraguay summed up the situation by saying that even though the country has nominally adopted compulsory metric usage there has been little change really in the use of weights and measures. The men he does business with still think and talk in arrobas (25.35 pounds). Thus, if the price of cotton is quoted at 15.50 pesos per kilo, the Paraguayan planter quickly multiplies by 10 (an arroba is approximately 10 kilos) and gets 155 pesos per arroba. He can then judge whether or not the offer is a good one.

Another fellow traveler, Mr. Alan D. Menmuir, whom the writer met on the S. S. General Alvear, en route to Buenos Aires, reported that he had seen in the interior of Paraguay arrobas used for measuring shelled corn (60 ears of corn to an arroba). He had also found that mano (handful) was commonly used as a measure; that thatching grass was sold by the vardo (bundle); and treacle by the cattle-hide-full. In this connection a letter [1/] from Dr. Weiss, who has lived for many years in the interior of Paraguay, gives the following information, "As to Paraguay there are still many old weights and measures used in the country," such as the almuda (1/3 bushel) which is used for salt and grains. The Guaraní, Caingua, Guayaquies, and the Chaco (Maca, Lengua, and so forth) Indians use primitive units such as: a man's weight, a child's weight, or a day's journey. In regard to the Argentine, Dr. Weiss writes:

1/See Appendix G, p. 327.

"There are still some very old weights in use for hides and sheepskins, such as una pesada. For dry hides a pesada is 35.45 pounds, for salted hides 60.77 pounds, and for washed sheepskins 30.38 pounds. There are many other customary weights and measures still widely used such as cuarta [1.05 pint], frasco [0.54 gallon], galón [6.69 pints], baril [20.08 gallons], and so forth, for liquids; and cuartilla [7.55 gallons], fanega [3.77 bushels], and so forth, for dry capacity."

The situation in the cities, however, is quite different. Stricter inspection and enforcement of the law, involving penalties of fines or imprisonment, or both cause people to devise methods of evasion. For instance, in Uruguay where the enforcement of metric usage is stricter than in any of the other South American countries visited by the writer, Mr. Calcraft, of the large importing concern, Castiglioni and Lucas-Calcraft, explained that, in order to comply with government regulations, which impose a fine if any weights and measures except metric appear in catalogues or newspapers, his company assigns approximate metric units to imported goods. Thus in their catalogue a package of Post Toasties is listed as weighing 330 gramos (11.65 ounces); a can of Towle's Log Cabin Maple Syrup 1.1 kilo (2.43 pounds); while Hiram Walker's London Dry Gin is listed as put up in a one litro[1/] botella (bottle). The writer was shown a bottle of United States Gin, which had the words "one quart" pressed in the glass, but which is called a litro bottle to evade the metric law. Another method of evasion was explained to the writer at Linn and Cia., general importers, who also do a large business in Uruguay. This company, for instance, sells Fairbanks-Morse windmills[2/] by number,

1/Litro (1.057 quart).

2/See Appendix H, p. 341. It should be noted also that Fairbanks, Morse, and Company in answering the Halsey export trade questionnaire wrote, "We have been actively engaged in developing foreign trade for the past 15 years, and our experience touches practically every country in the world. The lines of goods that we manufacture and sell abroad are quite varied, embracing internal combustion engines, steam, power, and centrifugal pumps, electrical dynamos and meters, railway supplies, and windmills.

"We are, of course, sending our goods to countries where the metric system is used, but we have not seen any necessity whatever for abandoning the English standard of weights and measures." Halsey, The Metric Fallacy, p. 41.

but the customer understands that these numbers refer to the height in feet. Thus a number 16 "molino" is a sixteen-foot windmill. A number 50 "torre" is another example of this, all parties concerned knowing that the tower is fifty feet high. The same subterfuge is used for screw threads, a number 16 meaning sixteen threads to an inch, the diameter being given in parts of an inch also as, for instance, 1/4 or 1/8. In Buenos Aires, Mr. Randall at the United States Consulate reported that this same method of evading the law is used in Argentina. Thus a number 32 bolt means thirty-two threads to an inch, the diameter being given also as 1/4, 1/8 and so forth, indicating the size in parts of an inch.

In the cities, too, the writer found many instances of disregard, as well as evasion of the metric laws. For example, in Buenos Aires a large shoe-manufacturing establishment uses English and metric units and local Argentine numbers. The writer was shown a scale on which there are four full sizes to an inch and two half sizes to a centimetre. This same factory buys hides by the foot. The writer also visited the Sociedad Anonima Fabrica Argentina De Alpargatas, large manufacturers of textiles, rope, and canvas shoes, and there interviewed Mr. W. E. Stuart Heath, who stated that cotton, 95% of which is grown in the Argentine, is bought by this company by the fardo (a bale, which varies in weight around 220 kilos,[1] approximately the same as the bale of cotton used in the United States[2]). A visit to the Sociedad Industrial Americana De Maquinaria, an Argentine firm which manufactures machinery for bakeries and service stations (underground tanks and gas pumps), refrigerators, water pumps, filters, and so forth, brought to light that sheet metal is bought in the Buenos Aires market more in inches

1/220 kilos (485 pounds).

2/480 pounds.

and fractions of an inch than in metric units. This concern, also, uses British and United States threads. Furthermore, the "Buenos Aires Herald" for September 1, 1939, carries an advertisement of tea by the pound and half pound, while under "Markets" maize, linseed, wheat, barley, raw cotton, and cakes (cotton) are quoted by the ton; silver by the ounce; sugar by the pound and hundredweight; rubber, maize, oats, and cotton by the pound; wheat and maize by the cental; and linseed, wheat, maize, and rye by the bushel. In the "Foreign Cotton Market" quotations the equivalent per kilo is given as well as per pound,[1] while in the "Foreign Grain Markets" the following metric equivalents are given:

cental (wheat and maize)	= 45.359 kilos (99.998 pounds)[2]
bushel (wheat)	= 27.215 kilos (60.01 pounds)
bushel (maize, linseed, and rye)	= 25.401 kilos (56.01 pounds)
bushel (oats)	= 14.515 kilos (32.01 pounds)
pound (maize) 480 pounds	= 217.72 kilos (479.985 pounds)
pound (linseed) 112 pounds	= 50.802 kilos (112.02 pounds)
pound (oats) 320 pounds	= 145.149 kilos (320.05 pounds)

The London and Paris Department Store, the largest in Montevideo, Uruguay, the writer found, sells gloves, which are made in that city by numbers 6 to 7 3/4, and men's and women's hosiery are marked with the same numbers as are used for sizes in the United States (8 1/2 to 10, and so forth).

In São Paulo the writer saw displayed for sale in a window of Mappin's Department Store, one of the largest in Brazil, a balanza de familia (household weighing machine), manufactured by Landers, Frary, and Clark Company of New Britain, Connecticut, U. S. A. This machine records the weight in both Portuguese libras (pounds) and onzas (ounces), and metric kilos and grammos, which indicates that customary units are used by housewives in Brazil.[3]

1/See Appendix H, p. 340.

2/The writer has added the equivalents in pounds for these metric equivalents.

3/See Appendix F, p. 308.

The United States Vice Consul in Santos reported that sugar is sold there by the arroba (32.47 pounds) and half arroba. A newspaper, "Folha Da Manha," published in Pernambuco, July 15, 1939, carries an advertisement, which offers to buy old gold by the grammo, but diamonds by the quilate (3.07 grains).[1/] Also "Brazil--Statistics, Resources, Possibilities," an official publication by the Ministry of Foreign Affairs for 1937, gives the production of babassu wood, and dessert fruits (pineapples, bananas, oranges, lemons, and tangerines) in hundredweight (pages 64, 75, and 174); and the production of cotton-down[2/] and meat (oxen, pigs, sheep, and goats) by the ton (page 197). A note in regard to the cotton-down production reads, "Equivalent, in bales of 500 pounds to: 1,252,230--1934-1935; 1,630,000--1935-1936," while the following note is added regarding wood production, "Value calculated at the price per ton exported abroad." On page 52 the mineral reserve of zircons in Brazil is estimated in tons. In the city of Manáos, northern Brazil, the writer found that wood for fuel is measured by the pé (12.99 inches); iron by the pé and pollegada (1.08 inch); rope by the braça (7.16 feet); silver by the oitava (56.88 grains); gold and precious stones by the quilate (3.07 grains); gasoline by the pipa (111.8 gallons); and paper by the resma (500 sheets for printing, 400 sheets for stationery). At the Casa Crocodilo in Belém, when the writer inquired the length of some snake and alligator skin belts, the clerk produced a tape-measure, on one side of which the units were centimetros and on the other pollegadas (inches). In another leather shop in the same city the writer again asked the length of belts, and the proprietor gave it in pollegadas, using a pollegada tape-measure.

1/See Appendix H, p. 335.

2/See Appendix H, p. 337.

Visits to markets afforded an opportunity of getting acquainted with the people as well as of observing the weights and measures, which they actually use in their everyday business transactions. The first one, which the writer visited, was the Mercado Publico at Manáos. It was necessary to go with a native guide, who could speak any of the dialects, which are common in the interior, because at dawn the cabôclos (half-breeds) paddle up to the shore in their dugouts or canoes which are filled with oranges, bananas, fish, or anything else they may have to sell. Little or no weighing takes place. At this time the wholesale buying goes on, the bidder offering a price for whatever he wants by the lot, usually buying all that a cabôclo has of one commodity. Oranges are sold by the hundred or half hundred. By six o'clock it was light enough to take a picture,[1/] and the open-air trading was finished soon after this. The cabôclos paddled away, and we visited the large indoor market next. Here meat, beans, and rice are sold by the kilo or by the more convenient half kilo (approximately 1 pound), while coffee is sold in 200 grammo (approximately 1/4 pound) packages. Farinha, however, is sold by the alqueire (1.03 bushel), and tobacco by the molha (large bundle), but as has been pointed out previously much is sold without using any weights and measures, an effective means of disregarding the governmental regulations in regard to compulsory metric usage. For instance, fish are sold by the string of four or five or by the piece (one whole fish or a half fish), vegetables by the bunch, tomatoes four or five for 100 réis (1/2 cent); and eggs three to five for a milréis (5 cents); yams by the piece; turtles by the piece or quarter; pumpkin by the slice; African oil by the bottle; and tucupy (cooking oil) by the can. The writer stopped at various stalls and recorded in a notebook what

1/See Appendix F, p. 302.

commodities were being sold by metric units; what by customary, and what without being weighed or measured. It was frequently necessary for the guide to make explanations to the market people in order to allay their suspicions since they naturally fear government inspection and penalties for not using metric weights and measures.

The open-air and indoor markets in Belém, the equatorial port at the mouth of the Amazon River, were also visited. Accompanied by the Consul's secretary, the writer arrived at the quay, where the open-air market was located, at about 5:30 in the morning. The cabôclos, arriving in their canoes before dawn, had unloaded their wares on the dock. Here wood for fuel is sold by the piece, by the feixe (bundle), or by the hundred pieces; string beans, carrots, radishes, lettuce, and scallions by the feixe (bundle); assahy berries, used for making a native drink, by the alqueire (1.03 bushel) or 1/2 alqueire; macacheira, a root used in place of potatoes, by the 1/4 alqueire (1.03 peck); tomatoes by the 1/8 alqueire;[1/] cará, a root used as a vegetable, by the 1/2 alqueire or by the paneiro (basket); farinha agua (flour water) by the 1/2 or 1/4 alqueire (1.03 peck); bananas by the cacho penca (small bunch); coal by the paneiro (basket); charcoal by the small, medium, or large paneiro (basket); tapioca by the basket (more than 1 kilo); batatas doces (sweet potatoes) by the 1/2 quarta (0.52 peck) or 1/8 quarta (1.03 quart); pineapples by the piece; bread (from a small wagon) by the piece or kilo; oranges by the hundred, by the basket (200 large ones or 250 small ones), and by the duzia (dozen); honey by 3 liter jars; gurijuba (dried fish) by the kilo. Cúias[2/] (gourds cut in half) are used extensively

1/See Appendix F, p. 303.

2/Cúya--cup.

for measures also. In the shops of the indoor market meat is sold by the kilo and 1/2 kilo; large fish by the kilo and 1/2 kilo; rice, beans, and corn by the kilo; farinha by the kilo and 1/2 and 1/4 kilo; but sugar and tobacco are sold by the arroba (32.47 pounds); tobacco also by the molha (large bundle); fish by the cambada (lots of ten on a cord) and wrapped in a palm leaf; shrimps by the handful; cheiro (pulverized, sweet-smelling woods used for sachets) by the handful; rubber by the pelle (the size of a hide); eggs by the duzia (dozen), or a certain number for a certain price--four for one milréis (5 cents); and wrapping paper by the cala (16 pounds). In this connection it should be noted that rubber is quoted in the Manáos newspaper, "A Tarde," July 10, 1939, by the pelle.

The writer visited several other Brazilian markets: the Mercado Modelo in São Salvador, Bahia; the Santos market; and the Mercado Municipal in São Paulo, the latter being one of the largest markets in South America. The findings were much the same in each instance, except that as the governmental inspection and control became stricter nearer the Federal District, fewer customary weights and measures were used, openly at least. In the São Paulo Mercado Municipal the writer found that cheese is sold by the jaca,[1/] a basket about a yard in length, containing from 14 to 16 cheeses; sugar by the arroba (32.47 pounds), bananas by the cacho (bunch of 9 dozen); palmita (palm hearts) and eggs by the duzia (dozen); oranges by the case of 100; apples, pears, and cherries by the cada (piece);[2/] farinha by 5 kilo (11.05 pounds) bags, 15 bags in a case; coffee in 60 kilo (132.6 pounds) sacks; strawberries by the kilo; and grapes by the kilo and 1/2 kilo. Tomatoes are brought in

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1/See Appendix F, p. 307.

2/See Appendix F, p. 307.

to the market from the farms in cases weighing 28 kilos (61.6 pounds), while vegetables are brought from the truck gardens in 10 arroba (324.7 pounds) baskets.

In the public market at Asunción, Paraguay, as has been mentioned above, the writer saw little actual weighing and measuring. This is accounted for by the fact that the great majority of the people have little money and so either barter or buy in very small quantities, bargaining for a certain amount for a certain price. The compulsory metric law has in reality brought about little change here. Thus the writer found that corn, potatoes, fruit, and truck garden products are bought and sold by the arroba (25.35 pounds); honey by the azumbre (0.53 gallon); and eggs and fruit by the docena (dozen). Meat is sold by the kilo, 1/2, 1/4, 1/8, and 1/16 kilo, and maté by the kilo, 1/2 kilo or 100 gramme (1/4 pound) bag.

The next two markets visited were the large Abasto market in Buenos Aires, Argentina, and the Central market in Montevideo, Uruguay. As might be expected metric units predominated, but the duodecimal docena (dozen) and binary fractions of the metric weights and measures are as commonly used in these markets as everywhere else.

Customary units were also found in use to a considerable extent for measuring land in the countries investigated by the writer. In Brazil the alqueire Paulista (6 acres) is used in buying and selling cattle-breeding property. An advertisement in the newspaper "O Estado De São Paulo" for August 3, 1939, reads, "Purchase a breeding farm, located on the São Paulo Central line, of 300 to 400 alqueires (1800 to 2400 acres) more or less. Write or communicate personally with Señor Luciano, Number 1 Patriarcha Square."[1/]

1/See Appendix H, p. 334.

People in all the countries where metric usage is compulsory have been unwilling to give up their convenient customary land measures, with which they are familiar, and to use in place of these the inconvenient "are" (119.6 square yards) or "hectare" (2.47 acres). In regard to cattle-breeding land, in particular, it is important to the Brazilian rancher to be able to visualize how many cattle can feed on an alqueire (6 acres). Cattle men in New Mexico, for instance, figure on 12 acres per year for every head of cattle. In this connection it should be noted that "Brazil--Statistics, Resources, Possibilities," mentioned above, gives on page 142 the area of coffee cultivation in alqueires (6 acres), and the coffee production in arrobas.[1] The area of zircon deposits is given in alqueires on page 52, while the area under cotton cultivation is given in alqueires, and cotton production in arrobas per alqueire.[2] A footnote states that, "This statistical data was furnished direct by the planters in the act of buying the seeds." The United States Vice Consul at Santos also reported the use of the alqueire Paulista (6 acres) in the interior.

In Buenos Aires, Argentina, the vara (2.84 feet) and the square vara (8.07 square feet) are commonly used for measuring land. The "Buenos Aires Herald" for August 28 and September 1, 1939, offer a number of examples of this. For instance, one advertisement reads, "Temperley in front of station 20 minutes from Constitution. New boarding house, just opened in park of 7000 varas /19,880 feet/. Ten front bedrooms," and so forth. The following is another advertisement: "Best part of Beccar, P. Uriburu corner of Acasuso, ground plot 450 vs. /1,278 feet/ to be sold. Two squares from station." A third reads, "Quinta house in Olivos, J. Ingenieros 1695, very comfortable,

1/Arroba metrica (33.3 pounds).

2/See Appendix H, p. 338.

garage, ground 43 x 60 vs. /varas/ for sale with facilities." A fourth advertisement is as follows: "In Villa Ballester 10,000 sq. vs. /80,700 square feet/ of ground to be sold with shade and fruit trees, in one lot or divided into fractions. Situated," and so forth.[1/] Needless to say metric measures are used also.

Timber land, cattle-ranches, yerba maté or quebracho properties, in fact all large estates in Paraguay, are sold by the legua or league (3.11 miles). Señor Davis Guttman, secretary at the United States Consulate reported. Legua is used too in speaking of distance. For instance, an Argentine lady whom the writer met on the S. S. General Alvear en route to Buenos Aires said she had been visiting at a ranch located 40 leguas (124.4 miles) from Posados. Deeds of land here also mention customary units as well as metric. In Appendix I (see pages 342-344) may be seen a "Transfer of Property," which the writer was permitted to copy from the correspondence of the American Consulate. The transfer is dated June 24, 1931, and pertains to lots of land in the capital city of Asunción. The second parcel of land consisting of parts of lots 2, 3, and 4 of Block D is thus described in this document: "Its frontage on Calle Tercera, now Calle Dr. Manuel Pérez, on the west measures 22 pies /feet/ with 4 pulgadas /inches/, 30 centivaras; or 7 meters, 188 millimeters,"[2/] and so forth. In Paraguay no property can be transferred unless all the documents, including the original deed, are produced. The file of the above transfer contained 14 official documents, the first of which related to its

1/See Appendix H, p. 339.

2/Pie (11.13 inches).
Pulgada (0.93 inch).
Centivara (0.33 inch).
Meter (3.28 feet).
Millimeter (0.039 inch).

subdivision from a large property in 1901, and the other 13 to subsequent transfers down to the last one in 1931. The old deeds, of course, give all the measurements in Spanish units, whereas the new deeds use both customary and metric measures.

In Uruguay old deeds give customary measures: varas (2.84 feet), square varas (8.07 square feet), and so forth; while new ones give only metric measures, if the property has not been sold before and so the document is an original deed. In rural districts, as in Paraguay, estancias (ranches) are bought and sold by the legua or league (3.11 miles) and by the cuadra (94.71 yards or 284.13 feet). The findings in regard to deeds were the same for both Argentina and Brazil.

Lumber, like wood for fuel, mentioned above, the writer found is sold by customary units. For instance, in Paraguay the unit "board meter" designates lumber which is one inch in thickness, one foot in width, and one meter in length. Mr. Randall at the United States Consulate in Buenos Aires, Argentina, reported that lumber there is measured by the pulgada (0.96 inch) and that logs are bought by the 1000 board feet.[1/] The board foot is used also in Uruguay.

Throughout the countries visited machinery and tools for the most part are calibrated to customary units, if they have been manufactured in the United States or England, but to metric units if made in countries having compulsory metric usage. Thus in São Salvador, Bahia, Brazil, the writer visited the largest textile mill, that of the Companhia Emporio Industrial Do Norte, which employs 1500 workers. Here the owner, Señor João Tarquinio, stated that most of the machinery in his mill has been imported from the

1/A board foot is one foot by one foot by one inch or 144 cubic inches.

United States and England, and therefore is calibrated to the inch, and measures in yards, but the folding machines measure in metros, because all the cloth must be sold according to the law by metric units. The two German engines in the mill, of course, have been manufactured to metric measurements. The writer in Rio de Janeiro also interviewed Mr. Lindsay Anderson of the Cia. America Fabrio, which operates a number of cotton mills employing some 5000 workers. The machinery used by this company was imported from the United States and England and therefore is calibrated and measures to the inch, but, Mr. Anderson reported, that a new measuring machine for the main mill has been ordered which will measure in metric units. In other words this company, one of the largest textile manufacturers in Brazil, is complying with the letter of the law in regard to selling by the metro, but like the mill in Bahia, is otherwise using customary units. Cotton is bought by the bale by this concern. In the factory of the Liceu De Artes E Oficios, a charity industrial school to which 650 boys go in São Paulo, a teacher stated that customary as well as metric units are used throughout the factory, but particularly in the machine shop and for mechanical work. Some of the German machines, which were pointed out to the writer, are equipped with gears in both inches and metric units. Also in São Paulo the writer visited a hardware store, the Confermat S/A, a French company, which sells tools imported from France. The clerk reported that none of these tools is marked in metric units only, but in both inches and centimetros. The steel tapes (100 foot) and foot rules which they sell also have inches on one side and centimetros on the other.

In Argentina, Mr. Randall at the United States Consulate (Buenos Aires) reported, machinery and tools are calibrated to the inch if they are imported

from the United States or England. Customary units, likewise, are used in repair shops, he stated. For instance, if it is necessary to rebore cylinders manufactured in either of those countries, the mechanics have to use inch calipers. Compulsory use of metric units in such a situation just isn't practical. The writer visited the Compañia Argentina De Electricidad (The Argentina Electric Company), and talked with Mr. Christianson, an engineer. He stated that in the new power station, which is being built at a cost of seven million pesos (approximately $2,000,000), 33 1/3% of the machinery has been bought from the United States; 33 1/3% from England; and 33 1/3% from Germany. Thus 2/3 of this new machinery will be manufactured to customary units except that, for the turbines and generators, which have been ordered from the General Electric Company of Schenectady, New York, metric units have been specified. Mr. Christianson also reported that as the British built the first railways in the Argentine, customary units are used for locomotives, wagons, railway coaches, and bridges. For the same reason sizes of pipe (diameters) for sanitary purposes and water are measured by the inch, although the length is measured by the metre. At the Sociedad Anonima Fabrica Argentina De Alpargatas, where jute-soled canvas shoes are made, the writer interviewed Mr. W. E. Stuart Heath and found that here they use English machines and United Shoe machinery [1] from the United States, all of which are built according to customary standards. They use too some German and Swiss machines, which are built according to metric standards. All

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1/The following statement by the United Shoe Machinery Company in an export trade questionnaire is of interest. It says, "Our company established factories in England, France, Germany, and Austria, and have exported goods and maintained subsidiary companies or branch offices in practically all of the countries of South America.

"In order to maintain uniformity, /for/ such machines as we manufacture both at home and abroad, the English system of measurements is used in all countries so that if necessary machines and parts may be supplied from one country to another." Halsey, The Metric Fallacy, p. 59.

their machines, which measure leather, do this by metric units. The writer also visited another factory which manufactures the same kind of shoes and cotton goods in Uruguay. Here the weaving machines are of English and North American make. Winding machines, manufactured in the United States, are used, and inch measurements are either converted into centimetres or the machines are adjusted to metric units.

Customary units are widely used, likewise, for imports and exports. En route to Brazil the writer interviewed the second officer on the S. S. Boniface (Booth Line), and found that the cargo consisted largely of high-test aviation gasoline, and coal, which was taken on at Philadelphia for use on Booth ships. The gasoline is shipped in wooden cases, each containing two 5 gallon cans. These are marked in United States units only and are sold all over South America, as oil is not refined there. The officer stated also that crude oil is exported to the United States and is marked in both metric and United States units. From the ship's records the following information was obtained: cargoes from Brazil, the only South American country to which the S. S. Boniface goes, are all in metric units except that wild cat skins are exported by the onça (1.01 ounce), but imports to Brazil are often in customary units. For instance, Port wine from Lisbon, Portugal, is shipped by the hogshead (57 gallons) or pipa (111.8 gallons); Claret by the hogshead (46 gallons) or pipa (115 gallons); Sherry by the hogshead (54 gallons); Madeira by the hogshead (46 gallons); but potatoes and garlic by the kilo. The weight of United States and English machinery and North American cars is given both in pounds and kilos, while coal and cement are imported by the ton. Mr. Goedhart, a fellow traveler, reported that hides and skins are sold from northern Brazil to the United States and England by the inch, but

that leopard and snake skins are sold by the pound.

In Rio de Janeiro bran is exported by the 100 pound bag,[1/] the writer found. A tailor shop, which employs fifteen workers was visited here, and the proprietor, José Trotta, stated that he imports cloth by the yard from England. For making a suit he allows three yards, but the actual measurements are taken in centimetros. In this connection Mrs. Maria Cole, a secretary at the United States Embassy, reported that dressmakers in Rio de Janeiro measure by centimetros exclusively. At the Lojas Americanas, of which there are five in Rio de Janeiro and eleven throughout Brazil, employing some 250 workers, Mr. Jensen stated that "yard goods" are imported by the yard, but sold by the metro; dress patterns are sold in United States sizes; and small articles such as: safety pins, buttons, hair nets, and so forth, are imported by the dozen and gross from the United States, Germany, and Japan. Coffee, it was found, is always exported from Brazil in 60 kilo (132.6 pounds) bags, whereas bananas are exported by the cacho (bunch of 9 duzia or dozen). At the factory of the Liceu De Artes E Oficios, a charity industrial school for boys, one of the teachers reported that oil and paints are imported from the United States and England by the gallon and the pint, while steel, brass, and other metals are imported by the ton. The official publication of the Ministry of Foreign Affairs for 1937, "Brazil--Statistics, Resources, Possibilities," gives banana production and exports in bunches (see pages 180 and 181), while "Sericultura" (Silk Culture) for June, 1938, gives raw silk imports from Japan in toneladas (1,814 pounds).

The writer interviewed Dr. Victor Riquelme, Director of the Facultad de Ciencias Económicas at the University of Asunción, Paraguay. He stated that wine is imported from the United States and England by the gallon, and oil

1/See Appendix F, p. 304.

from Spain by the galón (6.69 pints) while Mr. Root of the Algodones S/A reported that cotton is exported to England in kilos.

In Argentina, Mr. Randall at the United States Consulate[1] stated, cotton and wool are exported by the ton or bale (550 pounds);[2] casein (skimmed milk), horsehair, and tallow by the ton; goat skins by the bale; while horsehides as well as other hides are exported by the metric ton (2204.6 pounds). At the Cristalerias Rigolleau, one of the officials reported that the raw materials which this glass factory uses, such as sand, if imported from England are bought by the tonelada (0.904 ton), but from France and Germany these imports are by the metric ton (2204.6 pounds). The writer visited also the M. S. Bagley Cia., a large biscuit manufacturing company in Buenos Aires, and was informed that this concern imports in both metric and customary units. Paper and coal are imported by the ton. Mr. Burcham of the Saint Hermanos Cia., the largest manufacturers of chocolates in the Argentine, stated that cacao beans are imported by the pound from Trinidad and Ceylon, and that the prices are quoted in pounds. In the factory of the Sociedad Anonima Fabrica Argentina De Alpargatas, manufacturers of textiles and canvas shoes, the writer was informed that jute and sisal are imported from Calcutta, India, by the ton.

The writer interviewed Señor Zafiriadis at the United States Consulate in Montevideo, Uruguay, and he reported that: wool is exported by bales,[3] which may vary as much as 50 kilos (approximately 110 pounds), as there is no standard; and that meat is exported by the pound. In the London and Paris Department Store in this same city the writer found that the sizes of gloves, imported from France, Italy, Belgium, and England, are based on the inch and

1/Buenos Aires.

2/See Appendix F, p. 312.

3/See Appendix F, p. 313.

run from 5 3/4 to 7 3/4; imported perfumes are sold by the bottle, regardless of the units by which they were originally measured; while cloth and silk are imported from England, North America, and Japan by the yard. Señor Bermudez at Ancap (Administración Nacional de Combustibles, Alcohol, y Portland Cement), the largest industrial company in Uruguay and operated by the government, stated that their exports are sent to the United States and England by the pound; that corn beef, fertilizers, salted hides, pickled lambskins, and salted beef are exported in pounds everywhere, including Europe; that oil is imported in United States units; that crude oil is imported from the United States, Mexico, Venezuela, the Dutch West Indies, and Ecuador by the gallon, while price quotations are by the barrel (42 U. S. gallons); and that alcohol is imported from Holland by the dram. At the store of Castiglioni and Lucas-Calcraft, importers, Mr. Calcraft stated that liquors are imported by the botella, regardless of the units by which they have been originally measured. The writer was informed also at Linn and Company, that their imports: automobiles, machinery, plows, typewriters, dentist chairs, permanent-wave machines, tires, and so forth, are all manufactured in customary units. In the textile and canvas-shoe factory, Alpargatas, the writer found that jute is imported by the bale (approximately 400 pounds).

For river and sea navigation only customary units were found in use in the four countries visited. On the Amazon River, for instance, braça (7.16 feet) is used for taking soundings, while on the S. S. General Alvear, which runs between Asunción and Buenos Aires on the Paraná and La Plata Rivers, soundings are taken in pies (0.95 foot) and brazas (5.68 feet). The "Buenos Aires Herald" for September 1, 1939, published ship arrivals: British, Italian, American, Finnish, and Japanese. The names of the ships are given,

together with their tonnage, their cargo, and the names of the firms receiving the cargo; grain shipments also are given in tons. In this connection Señor Bermudez at Ancap (Administración Nacional de Combustibles, Alcohol, y Portland Cement) stated that this company charters Norwegian oil tankers, having a capacity of 9,000 to 15,000 long tons.

Another area in which customary units are used exclusively is that of time. In all the countries visited time is measured as in the United States, by dividing the twenty-four hours into two twelve hour periods, or as in Europe, by considering the twenty-four hours as one period and using 13 to 24 to designate the hours from 1 P. M. to 12 midnight. Thus 1 P. M. is 13 o'clock, and so forth. On page 28 of "Brazil--Statistics, Resources, Possibilities," a government publication mentioned above, the legal time in Rio de Janeiro is given as 7 mi. 6 s. 4 behind Greenwich time.[1/]

Temperature in the countries investigated is measured either by centigrade units or Fahrenheit or both. In Montevideo, Uruguay, the writer saw several outdoor thermometers, which had both the Fahrenheit and centigrade scales. Inquiries were made in a store, Pablo Ferrando, which deals in optical, photographic, and hospital supplies, and the writer was informed that all the thermometers, which this company carries, have both scales. Ancap (Administración Nacional de Combustibles, Alcohol, y Portland Cement) in the production of alcohol uses the Fahrenheit scale more than the centigrade the writer was told. The Bagley Biscuit Company in Buenos Aires, Argentina, however, uses only Fahrenheit thermometers.

Customary weights and measures, also, were found by the writer to be taught in the schools of Brazil, Argentina, and Paraguay. At Santarém,

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1/See Appendix H, pp. 335-336.

Pará, in northern Brazil, the Collegio Jesus Maria José, Escola Particular Mixta (a private school for boys and girls) was visited. About fifty pupils attend this school. The Headmistress stated that only metric weights and measures are taught but that the boys know the common customary Portuguese units because these are used in the market. She gave the writer a copy of the arithmetic book which the children use.[1/] On pages 24 to 27 the metric system is explained. Then follows:

"The System of Measures Adopted in Brazil"

"In Brazil the metric system has been adopted with some alterations, for there have been adopted, also, some measures of the customary system, the relations of some of which to the metric system have been defined in metric units, and some of which have not been defined in metric units.

"Of the metric system Brazil has adopted:

The metro and its divisions as a unit for measuring small dimensions.
The kilometro as an agrarian unit for measuring long distances.
The litro as a unit of capacity for small quantities.
The hectolitro as a unit of measure for large quantities.

"Also there has been adopted, for the convenience of commerce, the additional measures:

5 litros, 2 litros, and 1/2 litro.
The grammo as a unit of weight for medicines or precious metals.
The kilogrammo (abbreviated kilo) as a unit for larger quantities.
The are together with its multiple hectare as agrarian measures.
The metro cubico as a measure of volume.
The stereo which is little used.

"The franc has not been adopted, inasmuch as Brazil continues to use its old monetary system of which the real is the unit."

An explanation of Brazilian money follows, and then on page 28 there is a table headed:

"Old System"

"Of the old system Brazil has adopted the following measures which have been related to the metric system by assigning them metric equivalents:

1/ Taboadas Uteis (Useful Tables), Belém, Pará, Casa Editora de Porto de Oliveira e Companhia, 1939.

"Measures of Length"

braça	2 metros,2 [7.16 feet] [1]
vara	1 metro,2 [46.84 inches or 1.30 yard]
jarda	0 metro,914 [36.00 inches or 1 yard]
covado	0 metro,66 [25.98 inches]
pé	0 metro,33 [1/2 covado is 12.99 inches]
palmo	0 metro,22 [8.66 inches]
pollegada	0 metro,0275 [1.08 inch]

"Weights"

tonelada metrica	1,000 kilogrammos [2204.6 pounds]
quintal metrica	100 kilogrammos [220.46 pounds]
arroba metrica	15 kilogrammos [33.3 pounds]
libra	459 grammos,05 [1.01 pound]
onça	23 grammos,691 [0.84 ounce]
oitava	3 grammos,586 [56.88 grains]

"Measures of Capacity"

alqueire	36 litros,27 [1.03 bushel]
quarta	9 litros,0675 [1 peck]
selamin	1 litro,1334 [0.299 gallon]
pipa	420 litros, [110.96 gallons]
canada	2 litros,662 [0.70 gallon]

"Measures of Distance"

legua geographica	5553 metros [3.45 miles]
milha geographica	1852 metros [0.91 mile]

"Weight for Precious Stones"

quilate	1 decigrammo,922 [2.97 grains]

"The following units have not been related to the metric system by assigning them metric equivalents."

"Numerical Units"

milheiro	mil cousas [1000 things]
cento	100 cousas
mão	25 cousas
groza	12 duzias [dozen]
duzia	12 cousas

"Paper Units"

resma--para impressão [for printing]	500 folhas [sheets]
resma--para escrever [for stationery]	400 folhas [sheets]
mão	5 cadernos [quires]
caderno (quire)	5 folhas [sheets]

1/ Commas are used to indicate decimals. For instance a jarda is 0.914 metro.

The above table indicates that the libra is the customary Portuguese and Spanish pound; that the pollegada, pé, and palmo are the customary Portuguese units; and that the others such as: the quilate, the onça, alqueire, and milha, closely approximate the customary Portuguese units while the oitava differs by only 1 1/2 grains and the pipa by one gallon. The canada is 1/3 larger.

In Paraguay, Mr. Hughes, the Director of the Colegio International at Asunción, stated that in the primary grades the boys are taught only metric units but that in higher mathematics they deal with the customary weights and measures, also, and learn to use conversion tables.

The writer interviewed Señor Aldo Banchero, an inspector in the Buenos Aires public schools. He reported that in the Argentine schools metric units and the English system are taught.

The Conclusions

From the data of this field study the writer has drawn the following conclusions in regard to the three questions proposed for investigation on page 2.

1. That in spite of compulsory metric laws; government inspection; and penalties of fines, or imprisonment, or both, for any infraction of these laws, the customary weights and measures which are most convenient and so have become a part of the people's thinking, such as: the inch, the pound, the foot, the arroba (25.35 pounds),[1/] and the palmo (8.66 inches), are still used regularly in trade and industry.
2. That more than one-third, approximately 35%, of the units in use in trade and industry are customary weights and measures.

1/Spanish.

3. That some further effects of the compulsory use of metric units are:

   a. A mixed system of weights and measures (metric, English, and Spanish or Portuguese).

   b. Confusion.

   c. Much useless labor in calculating and using conversions.

   d. Disregard of the laws in the interior and in rural districts, and evasion as well as disregard in urban centers.

   e. A great amount of social and private cost to:

      (1) The governments, for inspectors and enforcement of unpopular laws which are either ignored or evaded as much as possible;

      (2) Business, industry, and trade for calculating conversions, and for machinery equipped with both customary and metric gages and devices.

   f. Increased difficulty in education, due to the mixed system of weights and measures.

4. That customary units are still used to a considerable extent in the measurement of land because:

   a. They are better suited to this purpose.

   b. They are an integral part of the people's thinking and experience, and so can be visualized--an important factor in buying and selling real estate particularly cattle-breeding and farm lands.

   c. They have been used in original deeds and, therefore, must be known and understood.

5. That the use of customary units predominates for machinery and tools, most of which are imported from the United States or England.
6. That lumber and timber which come from the interior or from the rural districts are measured, in general, by customary units.
7. That imports and exports are weighed and measured by customary units for the most part if they come from or are going to non-metric countries. In other words, the units used depend, in general, upon the place of origin or the destination of the goods.
8. That compulsory metric usage varies in direct proportion to the strictness of government inspection; the enforcement of the laws; and the severity of the penalties.

In regard to questions four, five, and six (see page 2) it should be pointed out first of all that it was not the purpose of this field study to answer these questions. Since, however, they inevitably arise in a study of this nature, the writer has formulated what seem, in her opinion, to be reasonable answers. They are:

That customary weights and measures continue to be used in disregard of the laws and in spite of severe penalties because:

1. Most of the people prefer them, since they are more convenient, having a practical relationship of units, due to the fact that they have developed through the process of natural selection, and since they are more adaptable to everyday needs and to ordinary industrial and business requirements as they may be multiplied and divided not only decimally, but binarily and duodecimally.
2. Compulsory metric laws cannot be enforced completely. Confiscation, fines, and imprisonment have not exterminated ingrained

habits of thinking and speaking in customary units.

3. Many of the industries have been developed by the English and by North Americans.
4. Manufacturing to a great extent has been developed by the English and by North Americans.
5. International trade is carried on largely in the English system.
6. They have proved to be better adapted to river and sea navigation.
7. They are unquestionably superior for measuring time.

That the metric substitute plan does not operate as a system with most of the well-advertised benefits such as economy in calculations and ease of learning because:

1. Only a few isolated metric units, such as: the kilo (1/2, 1/4, 1/8), the centimeter, the meter (1/2, 1/4, 1/8, 1/16, 3/4), the liter, and the ton, which approximate convenient customary weights and measures, are actually used to any extent.
2. Supplementary customary units such as: the arroba (25.35 pounds),[1] the palmo (8.66 inches), the braza (5.68 feet), the vara (2.84 feet), and so forth are commonly used, necessitating conversions which increase the amount of calculating.
3. The resulting mixed system (metric, English, and Spanish or Portuguese) makes learning in the field of weights and measures more complicated and difficult for children in school.

That metric units are modified or adapted by:

1. The use of binary fractions such as: 1/2, 1/4, 1/8.
2. The use of double units and other multiples such as: the double-

1/Spanish.

liter and 5 liters.

3. Adding customary units, legalized in metric values such as: the arroba metrica (33.3 pounds); the quilate metrico (3.086 grains); and the tonelada metrica (2204.6 pounds).

<u>A Comparison with the Halsey and Kennelly Data</u>

It is now possible to arrange, for comparison and study, the data from the three studies of metric usage; Halsey's, Kennelly's, and the writer's. Such a summary and comparison at this point will aid the further discussion of the general conclusions.

A comparison of the findings of the writer's field study (see page 159) with those of Halsey and Kennelly, in regard to the first question (see page 2) studied in this investigation, shows that the writer's first conclusion is substantiated by the data of these other two investigators. Table 8 gives the five customary units mentioned most frequently in the tabulations of the data of the three studies, and shows the number of times these units were mentioned (see next page). Thus the inch was mentioned in the Kennelly data 74 times, in Halsey's data 84 times, and in the writer's field study data 76 times; the pound was mentioned in the Kennelly data 58 times, in Halsey's data 22 times, and in the writer's field study data 33 times; the foot was mentioned in the Kennelly data 52 times, in Halsey's data 39 times, and in the writer's field study data 13 times; the arroba was mentioned in the Halsey data 18 times, and in the writer's field study data 32 times; the palmo was mentioned in the Halsey data 12 times, and in the writer's field study data 7 times.

Table 8. The Frequency of the Five Customary Units Mentioned Most Often in the Tabulations of the Data of the Three Studies.

Units	Kennelly Data	Halsey Data	Yorke Data	Total
Inch (pouce, pollegada, Zoll, pulgada)1/	74	84	76	234
Pound (Pund, livre, Pfund, libra, pond, libbra)2/	58	22	33	113
Foot (pé, pied, Fuss, Fot, voet, pie)3/	52	39	13	104
Arroba 4/		18	32	50
Palmo 5/		12	7	19

1/Pouce (1.18 inch)
Pollegada (1.08 inch)
Zoll (1.03 inch)
Pulgada (0.93 inch)

2/Pund (1.22 pound)
Livre (1.08 pound)
Pfund (1.03 pound)
Libra (1.01 pound)
Pond (0.91 pound)
Libbra (0.84 pound)

3/Pé (12.99 inches)
Pied (12.79 inches)
Fuss (12.36 inches)
Fot (12.35 inches)
Voet (11.15 inches)
Pie (11.13 inches)

4/Arroba (25 to 33 pounds)

5/Palmo (8.66 inches)

Table 9 gives a comparison of the writer's findings with the data of the other two studies in regard to the extent, in general, to which customary weights and measures are used in the countries studied. From this table it will be seen that the per cent of customary usage found by Halsey was approximately 44%; by the writer 35%; and by Kennelly 28%. In regard to the Kennelly data, it should be pointed out that he limited his investigation to internal commerce. If he had included industries and external commerce (international trade) the percentage for customary

Table 9. A Comparison of the Number of Times Customary and Metric Units Were Mentioned in the Writer's Field Study Data, the Data of Halsey's Study in South America, and the Data of the Study by Kennelly in Continental Europe.

Units	Halsey Study (Questionnaire) Brazil, Argentina, and Uruguay	Yorke Study (Field) Brazil, Argentina, Uruguay, and Paraguay	Kennelly Study (Field and Official Statements) Continental Europe
Customary	278	778	762
Metric	355	1434	1967
Total Number	633	2212	2729
Per Cent of Customary	44%	35%	28%
Per Cent of Metric	56%	65%	72%

usage would have been perceptibly higher.[1] The per cent of metric usage was approximately 56%, 65%, and 72% respectively.

The first effect, a mixed system of weights and measures, indicated by the writer in conclusion three (see page 160), is substantiated by both Halsey's and Kennelly's data, as Table 9 shows. The second effect, which deals with the confusion caused by the compulsory use of metric units, is supported by Halsey's findings. In regard to this he says, "The weights and measures of Latin America are in a state of chaos,"[2] while in another connection he speaks of "the confusion and disorder which prevail throughout Latin America,"[3] as a result of compulsory metric

1/See pp. 96-123 of this dissertation for further criticism of the Kennelly study.

2/Halsey, op. cit., p. 6.

3/Ibid., p. 12.

laws. The Kennelly data indicate that the same is true for continental Europe, examples of which are the several libras, which have been legalized at various metric values within the same country (Italy), and the two different Spanish palmos. The third effect noted by the writer (see page 160), is also corroborated by the findings of the other two investigators. The Halsey data indicate the common use of conversion tables in everyday business, as one of the comments in a questionnaire from Argentina shows. It is, "Best stores have conversion tables to inches," referring to clothing such as: collars, hats, and so forth. Some of Kennelly's findings in regard to the use of conversion tables in the field of education will be discussed below. The fourth effect, which deals with disregarding the compulsory metric laws, is supported by the data of both Halsey and Kennelly as the great number of customary units, shown by the tabulations to be in use, indicate. A statement regarding Germany in the Kennelly report says, "The old units of weights and measures, Elle (ell), Zoll (inch), and Pfund (pound) are still frequently applied in public buying and selling of wares."[1] The fifth effect, a great amount of social and private cost, necessarily results from disregard of the laws, while the sixth effect is supported by Halsey's data to the extent that they show that a mixed system (metric, English, Spanish or Portuguese) has resulted from compulsory metric usage in the countries studied. The Halsey questionnaire, however, made no inquiry regarding the educational aspect of this problem. The Kennelly data, too, show that in all the countries studied in continental Europe a mixed system has resulted, making learning in the field of weights and measures more complicated and difficult, involving conversion tables. The booklet, "Tablas

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1/Kennelly, op. cit., p. 84.

de Reduccion del Antigua Sistema al Metrico Decimal," referred to by Kennelly gives such tables for Burgos, while an elementary arithmetic, "Nociones Generales de Arithmetica," used in the same place, has two pages of tables of customary weights and measures. In this connection Kennelly says, "It was found to be a general rule in Spain, that the elementary arithmetic books devote attention to the old units. Each province has books with its own Table. This is entirely for local use, because the units differ materially in the different provinces, as already indicated."[1/] Likewise, he found conversion tables in the elementary Spanish arithmetic books used in Irun and in Madrid. Of the latter he says,

> "The space devoted to comparing old and new measures is, therefore, double that given to the metric system itself. The Chapter commencing on page 92, entitled (translation), 'Table of Old Castilian Weights and Measures,' has the following footnote: 'The royal decree of the 20th of November, 1910, approving a Sub-Secretarial order of the 29th of October, 1910, provides that, in the elementary public schools, the Decimal Metric System be taught to the exclusion of all others. One might, then, suppress in school all that here follows. Experience shows, however, that the old system of weights and measures cannot be completely laid aside at present; because there are still in force various documents containing the old units, and it is necessary to know how to interpret them. On this account, and also in order not to discredit the excellent treatment of the matter in this little work, these little directions have not been suppressed; but they have been collected and grouped here at the end, so that they may be availed of or not, according to the judgment of the teachers in charge.'"[2/]

In an arithmetic primer which Kennelly found in use in Palma, there were tables of old Majorcan weights and measures, together with a table of metric equivalents for the most important of these,[3/] while an Italian arithmetical primer, "L'Abbaco Ampliato,"[4/] had tables of old Bolognese measures and their

1/Kennelly, op. cit., pp. 144-145.

2/Ibid., pp. 137, 138.

3/Ibid., p. 148.

4/Ibid., pp. 115, 116.

metric equivalents.

The writer's fourth conclusion (see page 160), pertaining to the measurement of land, is substantiated by Halsey's data, summarized in his eleventh conclusion in which he states that the continued use of customary units "is most pronounced in the measurement of land." Also a comment in a questionnaire from Uruguay says that, "In the case of land measurement, a few old Spanish measures are authorized." Kennelly, too, says in the Introduction to his report, "In land tenure and registry also /in continental Europe/, the old units tended to persist much longer than in commerce. Occasionally, as in Austro-Hungary, the law made special provision for delay in compelling the change of land-area units. Title deeds expressing areas in old measures tend to remain undisturbed in family possessions for many years."[1] In regard to this matter in Switzerland, he states that, "Perches /8.55 square yards/ are also occasionally mentioned in advertisements of real estate appearing in the Lausanne newspapers,"[2] and for Italy he says that, "submetricised /customary/ units exist, especially in connection with land areas, where the surveys are still recorded in the old units."[3]

The fifth conclusion (see page 161) which the writer drew from the data of the field study, that the use of customary units predominates for machinery and tools, most of which are imported from the United States or England, is supported by Halsey's findings as he summed them up in conclusion 9 (see page 56). Kennelly, however, omitted industries in his investigation.

Halsey's eighth conclusion (see page 56) corroborates the writer's next finding concerning lumber while the Kennelly report gives supporting evidence

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1/Ibid., p. x.

2/Ibid., p. 81.

3/Ibid., p. 110.

in regard to this also. In a letter Mr. Edy Velander, an electrical engineer of the Swedish Royal Hydraulic Power Service, states, "One of the fields where non-metric measures are still used is the lumber industry. Not only are English feet and inches used, but also the old Swedish feet and inches. Moreover, the Danish feet and inches are used."1/ Another letter from Mr. H. E. Glahn gives the following information, "The woodworking industry is importing most of the wood used in Denmark, and is, on account of this, forced to use the measures in which wood is generally sold; so that in this industry you will find the foot and inch chiefly used."2/ For Germany it was reported that, "In the timber trade, the Rhineland inch (rheinischer Zoll) is still often employed"3/ and it was reported for Holland,

> "The Amsterdam inch frequently occurs in the timber trade. The timber consumer (carpenter) buys the timber by inches and feet, and deals with it in centimeters. The use of this measure is principally a consequence of conservatism. A well-known wholesale dealer in timber has succeeded in introducing the metric measurements into his trade. In general, the extension of the meter makes little progress here. The Rhineland measurement is rather in demand on measuring sticks, although it is not exactly known who is actually making use of it. It is likely that the timber trade with Germany has somewhat of an influence."4/

A third letter from the Chamber of Commerce at The Hague states that,

> "In some trades, the old measures, that have been in use since ever so long, have remained in use, which is especially the case with the timber and iron trades. As regards the timber trade, the inland trade reckons still with the Amsterdamsche duim /1.01 inch/ and the Amsterdamsche voet /0.93 foot/....Regarding the international timber and lumber trade....the English measures are in use, for the greater part, being based on the English inch and on the English foot. This custom is due to the trade with England, whereas its continuance is due, to a certain extent, to conservatism."5/

1/Ibid., p. 157.

2/Ibid., p. 155.

3/Ibid., pp. 86, 91.

4/Ibid., pp. 64, 65.

5/Ibid., pp. 60, 61.

Kennelly in his study did not investigate imports and exports although in his ninth conclusion (see page 64) he recognizes the fact that customary units are used in international trade. Halsey, however, made a study of exports by sending questionnaires to manufacturers in the United States. These results[1/] support the writer's seventh conclusion (see page 161) in regard to United States' exports and imports.

The writer's last conclusion (see page 161) is substantiated by Halsey's findings which he summarizes in his sixth conclusion (see page 56). The Kennelly report, however, gives no data in regard to the degree of government inspection, the enforcement of the laws, or the penalties.

In regard to questions four, five, and six (see page 2), the writer's opinions (see pages 161-163) are definitely supported by the findings and conclusions of the other two investigators. For instance, the first reason suggested by the writer for the continued use of customary weights and measures in disregard of the laws and in spite of severe penalties in the countries investigated is substantiated by the significantly large percentages of customary usage indicated by the tabulations of the data from the Halsey and Kennelly studies (see Table 9, page 165). Furthermore, Halsey's sixth conclusion, that "the impression made by the metric system is in direct relation to the severity of the laws," is in line with the writer's opinion, if to this statement is added the phrase, "and strict inspection and enforcement by means of penalties."

The second reason (see page 161), which has been indicated by the writer, is supported by the findings of the other two investigators. For instance, the unsigned official statements, as well as the unofficial ones, in Kennelly's report all emphasize that complete enforcement has not been

1/See p. 54 of this dissertation.

accomplished. The Halsey data, also, clearly indicate how the compulsory metric laws are disregarded and evaded, as much as possible, in the South American countries studied.

The third reason proposed by the writer, as to why customary weights and measures continue to be used in all the countries studied, is supported by the Halsey data regarding industries,[1] such as: mining, smelting, lumber, and railway (equipment), all of which have been developed in non-metric countries, and established in the South American countries studied, by foreigners chiefly from the United States and England, both of which are non-metric countries. On this point the Kennelly report, although industries were not investigated, gives the following statement from Holland, "Also the bicycle industry, originating in England, is entirely carried on with English measures."[2] The Halsey data, too, give supporting evidence in regard to the use of customary units in the manufacturing of ready-made clothing, hats, collars, underwear, hosiery, shoes, and gloves. Concerning this, Kennelly collected little or no data because he limited his study to commerce, but in his tenth conclusion (see page 64) he indicates that customary units do "occur in the manufacturing establishments of a metric country."

For exporting, importing, and in international trade, in general, Halsey's findings substantiate the writer's opinion. Kennelly, however, excluded any investigation of these in his study.

In regard to navigation, the writer's opinion is supported by the data of both Halsey and Kennelly. As a matter of fact, customary units are used exclusively all over the world for this

1/See pp. 84-85, 87-88, and 90-91 of this dissertation.

2/Kennelly, op. cit., p. 64.

purpose. In the Halsey investigation no mention of the measurement of time is made while Kennelly concludes that, "There seems to have been some suggestion of introducing decimalized time but this reform was never seriously attempted."[1/] It may be noted, also, that the French Republican Calendar was decreed on October 5, 1793 (retroactive to September 22, 1792), and that the old Gregorian calendar was restored on January 1, 1806. Thus the original metric scheme for the calendar lasted 13 years, 3 months, and 9 days in Paris.

The writer's opinion (see page 162) in regard to the use of only a few isolated metric units is supported by the tabulation of the Halsey data, which shows that 19 different metric weights and measures were mentioned but that, out of the total 355 times these were mentioned, 69% were the three units, kilo (1/2, 1/4), meter, and centimeter, while 78%, or approximately 4/5, were five units, the three mentioned above, and ton and liter.[2/] In the writer's data 22 different metric units were mentioned, while of the total number of times these were mentioned, exclusive of estimates, 69% were the three units, kilo (1/2, 1/4, 1/8), centimeter, and meter (1/2, 1/4, 1/8, 1/16, 3/4), while 82% were five units, the three above, and ton and liter. A comparison with the Kennelly data on this point cannot be made because there is insufficient data, exclusive of the estimates. The second reason (see page 162) indicated by the writer is substantiated by Halsey's data, which give practically the same supplementary customary units in use,

1/Ibid., p. 175.

2/

Kilo (1/2, 1/4)	112
Meter	79
Centimeter	52
Ton	18
Liter	17
Total	278

necessitating conversions, and so increasing the amount of calculating.

The third reason (see page 162) which the writer suggested has been discussed above.

The writer's opinion in regard to the sixth question (see page 2) is supported by Halsey's seventh conclusion (see page 56) and by the Kennelly data which show that metric units in continental Europe, also, have been modified or adapted by the use of binary fractions, such as the half kilo, and by the use of double units and other multiples, such as 5 liters, as well as by adding customary units, legalized in metric values such as the tonneau de jauge (100 cubic feet) in France and the Pfund (1.03 pound), Zentner (hundredweight), and Doppelzentner (double hundredweight) in Germany.

To summarize briefly, the tabulation of the data obtained from the field study, which the writer carried on in Brazil, Argentina, Uruguay, and Paraguay, indicated that the usage of customary weights and measures was approximately 35% of the total usage. The findings further indicated that, in general, the use of metric units in the interior is disregarded to a considerable extent; and evaded, when it is not possible to disregard it, in the cities where government inspection is stricter and the compulsory laws are more rigidly enforced by means of substantial fines or imprisonment, or both. It was found, also, that for the measurement of land, lumber, and fuel wood customary weights and measures are used frequently. Likewise, for machinery and tools, most of which are imported from the United States and England, the findings showed that customary units are used extensively, as they are, too, for other imports and exports. For river and sea navigation it was found that customary units are in use

exclusively, as they are, also, for measuring time. In the measurement of temperature both the Fahrenheit and centigrade scales are used. It was found, too, that children in the schools in three of the countries investigated must know customary as well as metric units, due to the mixed system of weights and measures in use. A comparison of the writer's findings in regard to the three questions (see page 2) studied in this investigation, with the data of Halsey and Kennelly show that, in general, the data of these other two investigators substantiate the writer's conclusions, thus strongly supporting the assumption that these conclusions are valid.

CHAPTER VIII

A SUMMARY OF THE STUDY AND THE CONCLUSIONS

A Summary of the Study

The problem was to discover what has happened in countries which have made the use of metric weights and measures compulsory by law, imposing penalties for the use of customary weights and measures.

Three questions (see page 2) were studied.

The investigation consists of three parts. The first is a preliminary background study (see pages 67 and 68). This is presented in Chapters II and III. Part II is a study of previous investigations pertinent to the problem, and is presented in Chapters IV and VI. Part III is an original field study, carried on by the writer in four South American countries. This is presented in Chapter VII.

The data from the three investigations (Kennelly's, Halsey's, and the writer's) were carefully tabulated. From these tabulations it was possible to compare the findings numerically, and thus to figure the metric and customary usage on a percentage basis.

The Conclusions

The evidence of the data, from representative and unbiased samplings in regard to the first question studied in this investigation (see page 2), indicates that the customary weights and measures which are used in trade and industry in the countries studied in continental Europe and in South America, where the use of metric units is compulsory, are those which are most convenient and so have become a part of the people's thinking. In all three studies the units which were mentioned most frequently were: the inch, the pound,

and the foot. In the South American data the arroba (25.35 pounds)[1] and the palmo (8.66 inches) ranked next in frequency.

The data indicate in regard to the second question that, after seventy-five years or more of compulsory metric usage, the per cent of customary usage in the four countries investigated in South America is approximately 35 per cent, while the per cent of metric usage is approximately 65 per cent. The Halsey data for South America (Brazil, Argentina, and Uruguay) indicate a slightly higher percentage for customary usage (44%), and the Kennelly data for continental Europe indicate a slightly lower percentage for customary usage (28%). Probably, however, as explained in pages 98, 124, 136, and 164 the actual usage of customary weights and measures exceeds these percentages.

The evidence of the data in regard to question three (see page 2) indicates that the compulsory use of metric units in the countries studied has had other important effects. One of these is that it has created a mixed system. A second effect is that it has caused confusion in thinking. A third effect is that it has necessitated much useless labor in calculating and making conversions. A fourth effect is the disregard and evasion of compulsory metric laws which have resulted. A fifth effect is that it has caused a great amount of social and private cost: first to the governments for inspectors and enforcement; and second to business, industry, trade, and commerce for calculating conversions and for machinery, equipped with both customary and metric gages and devices. Finally, it has made learning in the field of weights and measures more difficult for children in the schools, due to the fact that not a single system is in use as previously but a mixed system, and so conversions must be learned, as well as many additional units.

Obviously, questions four, five, and six are not within the scope of this investigation, and the writer makes no attempt to answer them

1/Spanish.

authoritatively but, because they do arise naturally in a study of this kind, the opinions which the writer has formulated will be presented. In regard to the fourth question, it is the opinion of the writer that customary weights and measures continue to be used in disregard of the laws and in spite of severe penalties in the countries investigated as a result, in general, of three factors. First, the great majority of the people prefer them because they are more convenient than metric units. This is due to the fact that customary weights and measures have developed through the process of natural selection, and thus there is a practical relationship between the units. Furthermore, they are more adaptable to the needs of everyday life and to ordinary industrial and business requirements because they may be multiplied and divided not only decimally, but binarily and duodecimally. Second, it is impossible to enforce the exclusive use of metric weights and measures because the use of customary units by the people is an ingrained habit of thinking and speaking. Fines and imprisonment, besides the confiscation of customary weights, measures, and weighing devices, have not succeeded in enforcing completely the compulsory metric laws. Third, customary units have been used in the development of many industries, and are used to a great extent in manufacturing, in international trade, and in commerce, as well as universally in navigation and sea measurements, and exclusively for time. Therefore the customary units have conveniences and values not easily laid aside.

The fifth question, dealing with the metric substitute plan, in the writer's opinion should be answered emphatically in the negative. First, the metric scheme does not operate anywhere as a system. The units most commonly used are those which approximate customary ones, such as: the kilogram, the 1/2 kilo (1/4, 1/8); the meter (1/2, 1/4, 1/8, 1/16, 3/4); the centimeter; the ton; the liter; and the kilometer. The cubic centimeter and gram are

useful in the chemical laboratory, but they are not convenient for ordinary purposes. The result is, that only a few isolated metric units, 1/ which are halved and quartered as are customary ones, are actually used, supplemented by convenient customary weights and measures, some of which have been legalized in metric values. Furthermore, the metric substitute plan does not make for economy in calculations because, inasmuch as the use of customary units continues, making conversions necessary, there results an increase in calculations (to the extent of conversions) rather than a decrease. Learning, too, in the field of weights and measures becomes more complicated and difficult because, when a mixed system is in use, not only must the metric units be understood and learned, but the customary ones which are commonly used must be learned, together with the necessary conversions.

Modifications or adaptations of metric units, referring to question six, have been made by using binary fractions, such as, 1/2, 1/4, 1/8; by using double units and other multiples such as 5 liters; and by adding customary weights and measures, legalized in metric values.

The Implications of the Study

One important implication of this investigation bears upon the educational question of teaching the metric system in the schools of the United States. The evidence beyond any doubt makes clear that it should not be taught as a basic system, which will ultimately replace our present one, because:

1. The metric system as such exists only on paper. Actually in use there are a few isolated units, together with their halves and quarters.

1/Kilogram (2.20 pounds).
Meter (1.09 yard).
Centimeter (0.39 inch).
Ton (2204.6 pounds).
Liter (0.91 dry quart or 1.06 liquid quart).
Kilometer (0.62 mile).
Cubic centimeter (0.06 cubic inch).
Gram (0.035 ounce).

2. The twenty-eight metric weights and measures which were legalized in the United States in 1866, are used scarcely at all except in laboratory work, where the gram and cubic centimeter are convenient. For such specialized work these particular units should be taught when needed.

3. The advantages claimed for metric weights and measures are pure academic theory. In practice they have more disadvantages than advantages.

4. Just as a nation's language cannot be taken away and replaced overnight, so its weights and measures cannot be either.

Another implication bears upon the question of whether or not metric usage should be made compulsory, enforced by penalties, in the United States. Again this study gives conclusive evidence that such compulsory legislation would be a great mistake because:

1. The use of twenty-eight metric weights and measures has been permissive for the past seventy-five years, and yet they have made no headway on merit.

2. The uniformity of the English system would be lost, and a mixed system would result, causing confusion and useless expense, such as have been experienced in Europe and South America. Furthermore, because the United States is a highly industrialized country, the confusion and expense of a forced change to metric units would be much greater than in South America, which was little developed industrially when the change was attempted there in 1862.

The Limitations of the Study

The investigator recognizes that this study has limitations, the most obvious of which is trying to get information from people in foreign countries and to interpret conditions with which the investigator in many

instances was not very familiar. Some of the specific difficulties encountered have been noted in Chapter V, pages 79-81. While the data were handled with extreme care, the investigator has taken the precaution of spreading them in the magnigraphs of the master-sheets (pages 125-135), so that the reader also may have the opportunity of studying and interpreting them, and thus of arriving independently at the right conclusions. The limitations indicated above are, however, common to any study. This one has been a forthright effort to discover the facts, to record them with meticulous honesty, and to interpret them without prejudice.

Suggestions for Further Study

While there appears to be little doubt as to the validity of the conclusions reached in this investigation, based upon the work of Halsey, Kennelly, and the writer, in such an important matter duplicate studies should be encouraged. The writer suggests, therefore, similar research in:

Germany and central Europe;

The Balkans, Greece, and Turkey;

Russia;

The Orient.

Another study, which would be interesting and helpful, is: the French government's propaganda for metric weights and measures--sponsors, purpose, methods, and expense.

A sixth study which is needed also is an accurate and unbiased history of weights and measures in the United States. The metric bias of the Bureau of Standards, for the past two generations, has tended to becloud this story in Bureau publications.

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Note: Additional original material, too voluminous to be included in the Appendices, is on file in the library of the School of Education at Boston University.

APPENDIX A

ILLUSTRATIONS OF ANCIENT WEIGHTS AND MEASURES

Appendix A1: Egyptian Stone Weights--Geometric Forms

Oblong Basalt Weight (8 Debens)[1/]
Inscribed with the name, "Iakh-hotep" and "8"
Old Kingdom I-XI Dynasties (3407-2112 B.C.)

1/ Approximately 4.45 ounces (the Old Kingdom deben was equivalent to about 208.33 grains). A small piece has been broken off the back and so the ancient weight is calculated to have been 4.66 ounces.

The size is 2 inches x 1 1/4 inches x 1 3/16 inches.

Appendix A1. (continued)

Rectangular Reddish Stone Weight (5 Debens)[1/]
The cartouche is that of King User-ka-ef, V dynasty.
(c. 2550 B. C.)

1/ Approximately 2.13 ounces or 0.13 pound.

The inch photographed with the weight indicates the size. For instance, the object in the photograph above is 14/16 of the actual size or not quite full size, since the inch in the photograph measures 14/16 of an inch.

Appendix A1. (continued)

Polished Porphyry Weight Used for Weighing Gold
Inscription on one side reading "Senusert, given life eternally, 70 gold debens"1/
XII Dynasty (2000-1788 B.C.)

1/Approximately 2.11 pounds.

The size is 3 3/4 inches x 2 5/8 inches x 2 3/8 inches.

This weight was found in the excavations of the Museum's Egyptian Expedition at the North Pyramid of Lisht (1913-14). See the report written by Arthur C. Mace in the Bulletin of the Metropolitan Museum of Art, New York, Vol.IX, No. 10 (October, 1914), pp. 218, 220.

Appendix Al. (continued)

Three Alabaster Weights
XII-XXII Dynasties (2000-1150 B.C.)
(2 Debens; 2 Debens; 2 Kidets)[1]

1/From left to right:
Approximately 0.92 ounce.
Approximately 0.99 ounce.
Approximately 0.60 ounce.

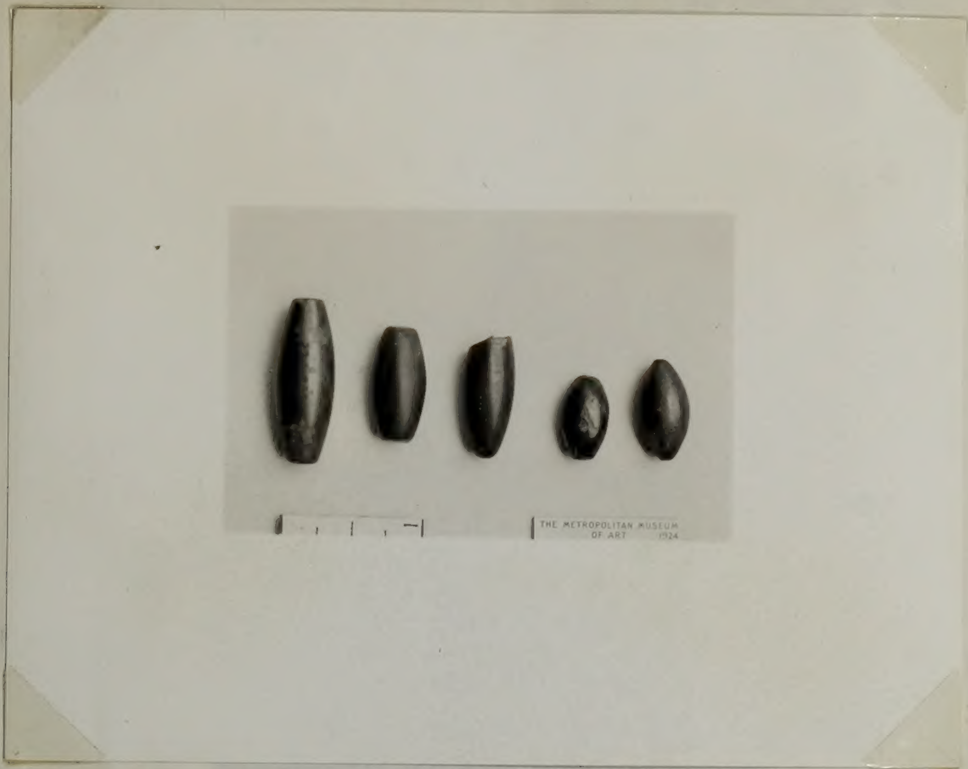
Found at the North Pyramid of Lisht.

Appendix A1. (continued)

Two Dioritic Stone Weights
XII-XXII Dynasties (2000-1150 B.C.)
(7 Debens; 5 Debens)1/

1/From left to right:
Approximately 3.50 ounces (slightly broken).
Approximately 2.72 ounces (slightly broken).
Found at the North Pyramid of Lisht.

Appendix A1. (continued)



Five Hematite Weights [1/]
XIV-XXII Dynasties (1878-1150 B.C.)

1/From left to right:
Approximately 0.34 ounce.
Approximately 0.17 ounce.
Approximately 0.18 ounce (one end broken off).
Approximately 0.10 ounce.
Approximately 0.17 ounce.
Found at the North Pyramid of Lisht.

Appendix A1. (concluded)

Limestone Weight (40 Kidets)[1]
Inscribed with "40"
XX-XXII Dynasties (1580-1150 B.C.)

1/Approximately 3.83 pounds (broken considerably).
Found at Lisht.

Appendix A2. Egyptian Bronze Weights--Animal Forms

Bronze Ox's-head Weight (2 Kidets)[1]
Cast hollow and filled with lead
to make the required weight.
Empire or Imperial Period (1580-1090 B.C.)

1/Approximately 0.62 ounce.

Appendix A2. (continued)

Bronze Recumbent Ox Weight[1/]
Cast hollow and filled with lead
to make the required weight.
Empire or Imperial Period (1580-1090 B.C.)

1/Approximately 2.08 ounces.

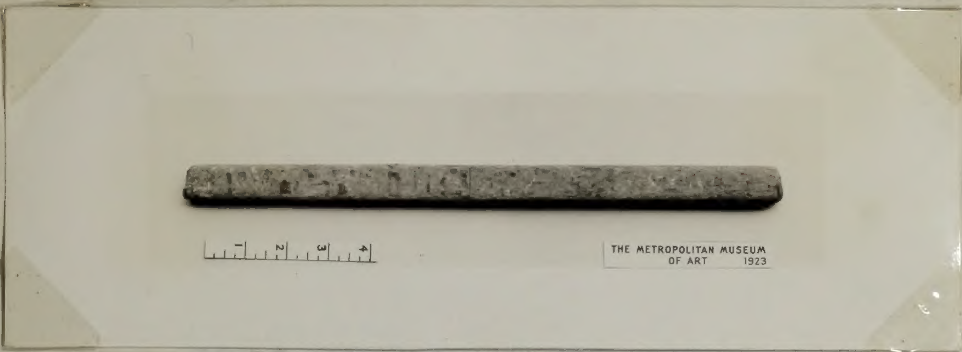
Appendix A2. (concluded)

Bronze Recumbent Cow or Calf Weight (6 Debens)[1/]
Filled with lead, which was poured in through
a hole in one side to make the required weight.
Empire or Imperial Period (1580-1090 B.C.)

1/Approximately 2.97 ounces (slight break on the bottom, some of the lead being lost).

The size is 2 7/16 inches.

Appendix A3. Egyptian Measuring Rods



Wooden Measuring Rod (7 Palms)1/
Ordinary rod for measuring short distances.
Divided into 7 approximately equal parts,
and into 2 equal parts.
XX-XXII Dynasties (1580-1150 B.C.)

Fragment of a Green Slate Cubit Rod
New Kingdom (1580-945 B.C.)

This shows the first digit and a part of the second. The Royal Cubit (20.6 inches) is labeled in the inscription. The complete rod was divided into 7 palms. Each of the first 4 palms was divided into 4 digits. The first 15 digits were subdivided: the first digit into halves; the second into thirds; and so on up to the fifteenth digit, which was subdivided into sixteenths.

1/Approximately 27.5 inches.

Found at the North Pyramid of Lisht.

Appendix A4. Egyptian Glass Weights

Fused Glass or Syenite Ring Weight
Roman Period (30 B.C.-639 A.D.)

Olive Green Translucent Glass Weight 1/
Bears the name of Fatimid Caliph, Al Hakim al Mansur
Arabic Period (996-1020 A.D.)
From Der el Ballas

1/Weight 0.138 ounce. Diameter 0.95 inch.

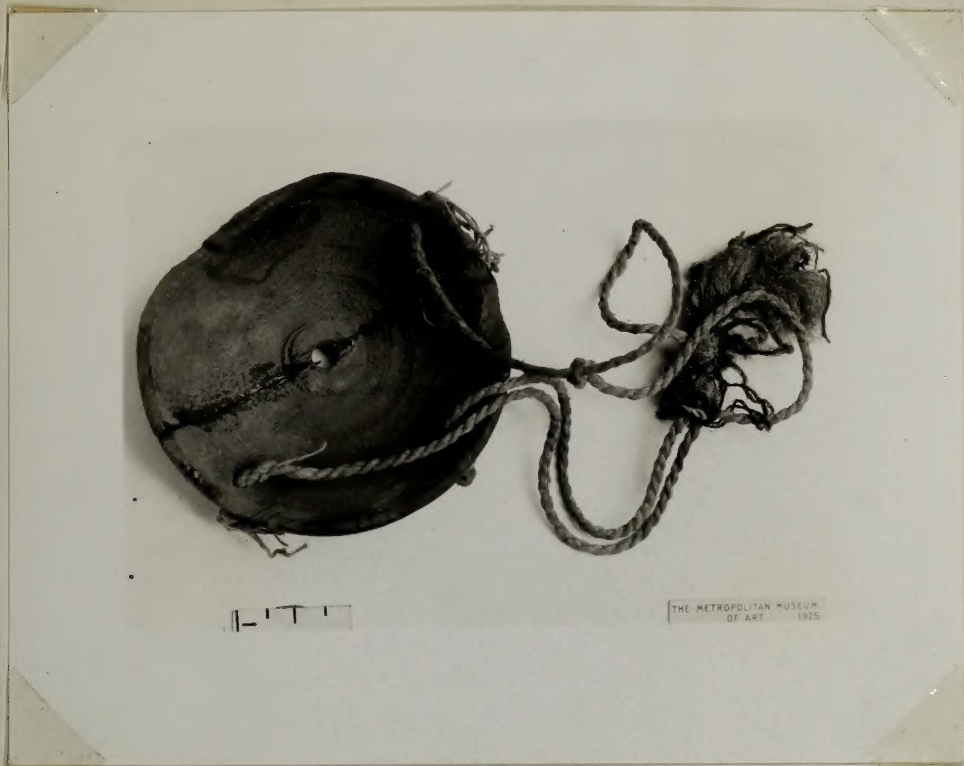
Note: The Metropolitan Museum of Art in New York "has also a glass weight shaped like a bull's head....although the nose is broken off. It was found in 1911 by the Museum's Expedition at the Palace of Amenhotep III at Thebes, and it dates from the XVIII dynasty (c. 1500 B.C.). Owing to its broken condition, however, neither its weight nor its denomination can be determined."

Bernice M. Cartland, Egyptian Weights and Balances, New York: Bulletin of the Metropolitan Museum of Art, Vol. XII, No. 4 (April, 1917), p. 90.

Appendix A5. Bronze Ingot

Weighs 61.96 pounds
From Asia Minor (?)
Bronze Age

Appendix A6. Egyptian Weighing Machines



Wooden Balance Pan
Roman Period (30 B.C.-639 A.D.)
From Oxyrhynchus

Appendix A6. (continued)

Small Bronze Hand-balance in Wooden Box
Coptic Period[1]

"It consists of a cylindrical beam and needle made of one piece of metal, a handle shaped like a pair of tongs, and two pans. The needle projects from the top of the beam exactly in the middle, making the two arms equal. The two prongs of the handle are fastened by a pin to either side of the needle above the beam. The beam oscillates on this pin which serves as a pivot, and the scales are evenly balanced when the needle and handle exactly coincide. The ends of the beam and the top of the handle are beaded and there are rings for suspension in all three places. The two pans of thin sheets of bronze, each in the shape of a watch glass, pierced on the edges with three holes for suspension, originally hung from the ends of the beam....This balance was kept in an inlaid wooden box, partitioned inside to keep the scales in place, with a compartment at one end, probably for weights. Such a weighing machine, though sensitive, was simple and practical for weighing small objects. It is occasionally pictured in drawings of the zodiac or as actually in use."[2]

1/The Metropolitan Museum of Art states that it is "not possible to designate a definite period" for coptic, but that the time of greatest floruit was from 200-640 A.D.

The length of the beam is 6 1/16 inches; the length of the handle 1 7/8 inches; and the diameter of the pans 2 1/8 inches.

2/Cartland, op. cit., pp. 85-86.

Appendix A6. (concluded)

Bronze Steelyard

The bar is marked on three sides with various gradations of scale marks.

Roman Period (30 B.C.-639 A.D.)

From Jebiel, Syria

Appendix A7. Egyptian Water-clock

Green Faience Model of an In-flow Klepsydra [1]
Late Dynastic (945-663 B.C.)

1/ A water-clock. This took a certain length of time to fill (in-flow), the time at any given moment being shown by the level which the water had reached on an inscribed scale. There are no water-clocks extant.

Appendix A8. Egyptian Nilometer

Green Faience Nilometer
XXX Dynasty (387-341 B.C.)

Appendix A9. Wisconsin River Gage

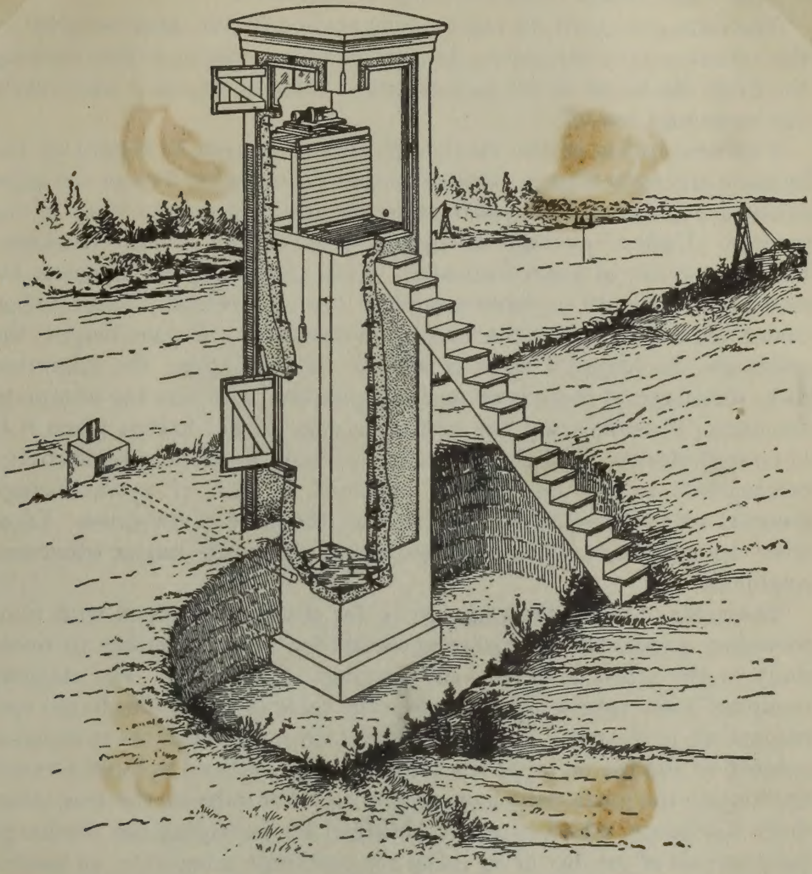
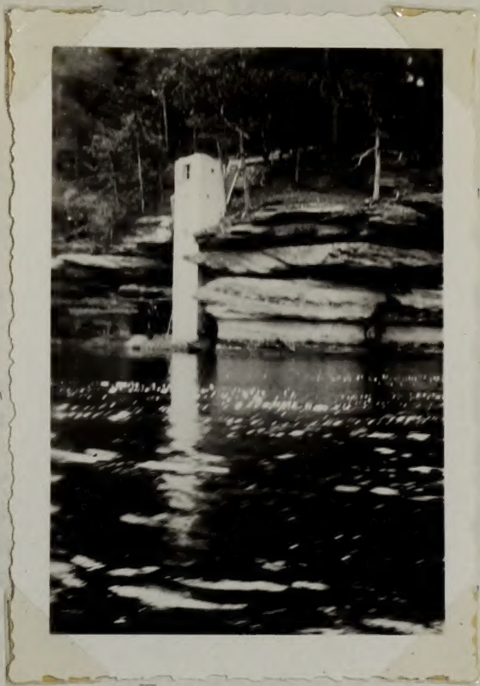


FIGURE 1.—Typical river-measurement station showing concrete well and house for water-stage recorder and staff gages, cable, and car.

The origin of modern river-gages may be traced back to the ancient Nilometers.[1] "The base data collected at a gaging station [such as may be seen on the Wisconsin River at the Lower Dells], consists of records of stage, measurements of discharge, and general information used to supplement the gage heights and discharge measurements in determining the daily flow. The records of stage are obtained either from direct readings on a staff or chain gage, or from a water-stage recorder that gives a continuous record of the fluctuations. Measurements of discharge are made with a current meter....A typical gaging station, equipped with water-stage recorder and measuring cable and car, is shown [in the above diagram]." Surface Water Supply of the United States 1933, Part 4, Geological Survey Water-Supply Paper 744, United States Department of the Interior, Washington: Government Printing Office, 1935, pp. 3-4.

1/See Appendix G, p. 332 for letter from Mr. F. C. Christopherson.

Appendix A9. (concluded)



Wisconsin River Gage Station

This gage at the lower Dells is operated "for the purpose of continuously recording the stage of the Wisconsin River. It is equipped with a float-actuated pencil which marks the river height continuously on a strip of cross-section paper traveling at a uniform time rate by means of a clock mechanism....

"The purpose of collecting stage records is to obtain the volume of daily discharge of the Wisconsin River at this point. The discharge of a stream is obtained by applying the daily stage record to a rating curve which defines the relation between stage and discharge. The rating curve is plotted from the results of discharge measurements made by our engineers using a current meter from the suspension cable and car which you may have noticed a short distance downstream from the lower Dells gage. Records of daily discharge for this station and for 3,830 other gaging stations in the United States are published yearly in the U. S. Geological Water Supply Papers....

"Our gages are in principle similar to the nilometer of Egypt; only we obtain, in addition, the volume of stream flow."1/

1/The above is quoted from a letter written by Mr. F. C. Christopherson, District Engineer in the Public Service Commission of Wisconsin. See Appendix G, p. 332.

APPENDIX B

UNITED STATES' LAWS AND METRIC BILLS

REGARDING WEIGHTS AND MEASURES

Appendix B1. Laws of the United States in regard to Weights and Measures

I. Article I, Sec. 8 of the Constitution.[1/]

"The Congress shall have power to....fix the standards of weights and measures."

II. The Permissive Metric Law, an Act to Authorize the Use of the Metric System of Weights and Measures.[2/] Enacted July 28, 1866.

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this act it shall be lawful throughout the United States of America to employ the weights and measures of the metric system; and no contract or dealing, or pleading in any court, shall be deemed invalid or liable to objection because the weights or measures expressed or referred to therein are weights or measures of the metric system.

"Sec. 2. And be it further enacted, That the tables in the schedule hereto annexed shall be recognized in the construction of contracts, and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the metric system; and said tables may be lawfully used for computing, determining, and expressing in customary weights and measures the weights and measures of the metric system:"

"Measures of Length"

Metric Denominations and Values		Equivalents in Denominations in Use
Myriameter	10,000 meters	6.2137 miles
Kilometer	1,000 meters	0.62137 mile or 3,280 feet and 10 inches
Hectometer	100 meters	328 feet and 1 inch
Dekameter	10 meters	393.7 inches
Meter	1 meter	39.37 inches
Decimeter	1/10 of a meter	3.937 inches
Centimeter	1/100 of a meter	0.3937 inch
Millimeter	1/1000 of a meter	0.0394 inch

1/Harper, op. cit., Constitution of the United States, Art. I, Sec. 8.

2/Public Laws of the United States of America, Passed at the First Session of the Thirty-ninth Congress; 1865-1866, Ch. 301, p. 339.

Appendix Bl. (concluded)

"Measures of Surface"

Metric Denominations and Values		Equivalents in Denominations in Use
Hectare	10,000 square meters	2.471 acres
Are	100 square meters	119.6 square yards
Centare	1 square meter	1550 square inches

"Measures of Capacity"

Metric Denominations and Values			Equivalents in Denominations in Use	
Names	Number of Liters	Cubic Measure	Dry Measure	Liquid or Wine Measure
Kiloliter or stère	1,000	1 cubic meter	1.308 cubic yard	264.17 gallons
Hectoliter	100	1/10 cubic meter	2 bushels and 3.35 pecks	26.417 gallons
Dekaliter	10	10 cubic decimeters	9.08 quarts	2.6417 gallons
Liter	1	1 cubic decimeter	0.908 quart	1.0567 quart
Deciliter	1/10	1/10 cubic decimeter	6.1022 cubic inches	0.845 gill
Centiliter	1/100	10 cubic centimeters	0.6102 cubic inch	0.338 fluid ounce
Milliliter	1/1000	1 cubic centimeter	0.061 cubic inch	0.27 fluid dram

"Weights"

Metric Denominations and Values			Equivalents in Denominations in Use
Names	Number of Grams	Weight of What Quantity of Water of Maximum Density	Avoirdupois Weight
Millier or tonneau	1,000,000	1 cubic meter	2204.6 pounds
Quintal	100,000	1 hectoliter	220.46 pounds
Myriagram	10,000	10 liters	22.046 pounds
Kilogram or kilo	1,000	1 liter	2.2046 pounds
Hectogram	100	1 deciliter	3.5274 ounces
Dekagram	10	10 cubic centimeters	0.3527 ounce
Gram	1	1 cubic centimeter	15.432 grains
Decigram	1/10	1/10 cubic centimeter	1.5432 grains
Centigram	1/100	10 cubic millimeters	0.1543 grain
Milligram	1/1000	1 cubic millimeter	0.0154 grain

Appendix B2. Metric Bill (H.R. 123)[1] (Not Enacted)

"A bill to adopt the weights and measures of the metric system as the standard weights and measures in the United States.

"1. Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled,

"2. That on and after the first day of January, 1904, all the departments of the Government of the United States, in the transaction of all business requiring the use of weights and measurement, except in completing surveys of lands, shall employ and use only the weights and measures of the metric system; and on and after the first day of January, 1907, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States."

Appendix B3. Ladd Metric Bill (S2267)[2] (Not Enacted)

"Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That from and after ten years from the date of passage and approval of this act the weights and measures of the meter-liter-gram or metric system shall be the single standard of weights and measures in the United States of America for the uses set out herein.

"Sec. 2. That the national prototypes of the fundamental standards of the metric system shall be the copies of the standards known as meter numbered twenty-seven and kilogram numbered twenty, allotted to the United States by the General Conference of Weights and Measures, held at Paris in 1889. These are now deposited in the vault of the Bureau of Standards of the Department of Commerce, and are those which are now used and employed in deriving the values of all weights and measures used in the United States. These national representations are hereby adopted as the primary standards of weights and measures for the United States of America, and from these all other weights and measures shall be derived and ascertained.

"Sec. 3. That from and after ten years from the date of passage and approval of this act no person shall do, or offer or attempt to do, any of the following acts, by weights or measures, in or according to any other system than the metric system of weights and measures, namely:

"(1) Sell any goods, wares, or merchandise, except for export, as provided in Section 8;

"(2) Charge or collect for the carriage or transportation of any goods, wares, or merchandise.

"Sec. 4. That from and after ten years from the date of passage of this act no person shall use, or attempt to use, in any of the transactions,

1/American Society of Mechanical Engineers Report No. 972, op. cit., pp. 699, 700.

2/United States Hearings, 1922, op. cit., pp. 3, 4.

detailed in Section 3, any weight or measure, or weighing or measuring device designed, constructed, marked, or graduated in any other system than the metric system of weights and measures.

"Sec. 5. That not later than ten years from the date of passage and approval of this act all postage, excises, duties, and customs charged, or collected by weights or measures, by the Government of the United States, shall be charged or collected in, or according to the metric system of weights and measures.

"Sec. 6. That rules and regulations for the enforcement of this act not inconsistent with the provisions hereof shall be made and promulgated by the Secretary of Commerce. The Secretary of Commerce shall also take such steps as he may deem expedient for giving publicity to the dates of transition specified herein, and for facilitating the transition to the meter-liter-gram or metric system.

"Sec. 7. That all acts or parts of acts inconsistent herewith are hereby repealed, but only in so far as they are inconsistent herewith; otherwise they shall remain and continue in full force and effect. Whenever in any act, or rules and regulations, or tariff, or schedule made, ratified, approved, or revised by the Government of the United States of America, weights or measures of the system now in customary use are employed, or referred to, and to comply with the provisions of this act weights and measures of the metric system should be employed, then such references in such act, rules and regulations, tariff, or schedule shall be understood and construed as references to equivalent weights or measures of the metric system, ascertained in accordance with the required degree of accuracy.

"Sec. 8. That nothing in this act shall be understood or construed as applying to:

"(1) Any contract made before the date at which the provisions of this act take effect;

"(2) The construction or use in the arts, manufacture, or industry of any specification or drawing, tool, machine, or other appliance or implement designed, constructed, or graduated in any desired system;

"(3) Goods, wares, or merchandise intended for sale in any foreign country, but if such goods, wares, or merchandise are eventually sold for domestic use or consumption, then this clause shall not exempt them from the application of any of the provisions of this act.

"Sec. 9. That nothing herein shall be understood or construed as prohibiting the enactment or enforcement of weights and measures' laws or ordinances by the various States or cities, and the various States or cities shall have the same powers as though this act were not in force and effect: provided, however, that no standard weights or measures shall be established for the uses set out herein, which conflict in any way with the standards established herein, and such standards, which may already have been established, shall be null and void for the uses set out herein.

Appendix B3. (concluded)

"Sec. 10. That the word 'person' as used in this act shall be construed to import both the plural and singular, as the case demands, and shall include corporations, companies, societies, and associations. When construing and enforcing the provisions of this act, the act, omission, or failure of any officer, agent, or other person acting for, or employed by any corporation, company, society, or association, within the scope of his employment or office, shall in every case be also deemed to the act, omission, or failure of such corporation, company, society, or association as well as that of the person."

Appendix B4. Britten Metric Bill (H.R. 10)[1] (Not Enacted)

"Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That from and after the 1st day of January, 1935, metric weights and measures, except as herein provided, shall be used for the following purposes:

"(1) For buying or selling goods, wares, or merchandise, unless permission to use other weights and measures has been granted by the United States Department of Commerce, or by a State department of weights and measures, or by an authorized State official.

"(2) For charging or collecting for the transportation of any goods, wares, or merchandise, unless permission has been granted to do otherwise by any of the authorities designated above.

"Sec. 2. Not later than the 1st day of January, 1935, all postage, excises, duties, and customs charged or collected by weight or measure by the Government of the United States of America, shall be charged or collected in terms of, or according to metric weights and measures.

"Sec. 3. Nothing in this act shall be understood or construed as applying to:

"(1) The construction or use in the arts, manufacture, or industry of any specification, drawing, goods, wares, merchandise, tool, machine, or other appliance or implement designed, manufactured, constructed, or graduated in any system of measurement.

"(2) The ordering, buying, or selling of manufactured articles, such as tools, machines, or parts of machines, ordinarily known by, or designated in terms of any other system of weights or measures.

"(3) Any contract made before the 1st day of January, 1935.

"(4) The survey or description of lands within the jurisdiction of the United States of America, or transactions in lands or real estate therein.

"(5) The sale of goods, wares, or merchandise originally intended for any foreign country.

1/United States Hearings, 1926, op. cit., p. 1.

Appendix B4. (concluded)

"Sec. 4. After the 1st day of January, 1935, the terms 'world yard' for the 'meter,' 'world quart' for the 'liter,' and 'world pound' for 'five hundred grams' shall be recommended for international use, and accepted as metric terms.

"Sec. 5. All acts or parts of acts inconsistent herewith are hereby repealed, but only in so far as they are inconsistent herewith; otherwise they shall remain and continue in full force and effect.

"Sec. 6. Rules and regulations for the enforcement of this act shall be made and promulgated by the Secretary of Commerce, who shall also take such steps as he may deem necessary to make this act effective."

APPENDIX C

DETAILED SUMMARIES OF REPORTS AND HEARINGS

REGARDING PROPOSED METRIC BILLS

Appendix C1. Summary of Report Number 972 of the American Society of Mechanical Engineers

This report, which is an unsurpassed analysis of the arguments for and against the metric system, was made by a committee, appointed to make the study in reference to the proposed metric bill (H.R. 123).[1] The arguments are as follows:

"Arguments in Favor of the Metric System."

"1. It is a rational system that harmonizes with the world's arithmetical notation, and it is the only method so far proposed that bears any promise of becoming universally international, thus facilitating commercial exchanges and encouraging international trade.

"2. The correlations established between /the/ measures of length, weight, and volume, together with the uniform decimal enumeration, tend to facilitate and simplify computation and reduce the necessity of memorizing tables of

"Replies to Arguments in Favor of the Metric System."

"1. The metric system harmonizes with the world's notation in so far as that notation for computing is a decimal one, but it does not harmonize with the universal system of binary subdivision of measures of length. The names also of the several units do not harmonize with the Anglo-Saxon terms so largely used. The metric system bears no promise of becoming universally international, unless the English and the United States governments should restrict the liberties of the people by compulsory legislation in favor of this system. The use of the English system in manufacturing is not an obstruction to international trade, because anyone engaged in such trade is at perfect liberty to use the metric measures in his catalogues and correspondence.[2]

"2. The alleged 'correlation between /the/ measures of length, weight, and volume' of the metric system, applies only to the relation between the measures of length and the weight of distilled water at a certain temperature; for any other material whatever, recourse

1/See Appendix B, p. 209, for proposed bill.

2/Samuel S. Dale, "Committee Report No. 972 on the Metric System," pp. 687-690, 708, 711.

Appendix C1. (continued)

weights and measures, thus saving time in the school, the office, and the workshop, and simplifying work for all.

must be had to tables of specific gravity, while in the English system reference is made directly to tables of weight per cubic foot, which are certainly just as simple and easily memorized as specific gravities. The facilitating and simplifying of computation by the metric system is true only in certain selected cases. In other cases the English system is just as simple, or simpler. As to the necessity of memorizing tables of weights and measures, those....of English weights and measures in customary use by everybody are simpler; have fewer names; and require less time in school than the metric....1/

"3. We now use a mixed system of decimal and binary fractions and the common practice of changing binary to decimal fractions in computations, and then changing back again for the result, would be abandoned, together with all the sources of error to which those processes are liable.

"3..../Using/ a mixed system of decimal and binary fractions....is entirely a matter of choice and convenience; anyone can use either system....The trouble of computing and changing back from one system of fractions to the other is a trouble which is experienced only by a very small fraction of the population....Those who have much computing to do facilitate their work by the use of tables of corresponding decimals and binary fractions.

"4. The metric system, being decimal, is well adapted for slide-rule computations....Consequently /this device/ is more frequently used in Germany than in England, where..../it/ originated. /The system/ is also better adapted to all mechanical computing devices and to logarithms, which are not applicable to common fractions.

"4. The decimal system in itself is not the metric system, because the English system may be used decimally just the same as the metric....in fact surveyors use the foot and its decimal sub-division of .001 of a foot regularly in their computations, while the draftsman and machinist is at perfect liberty to use .01 and .001 of an inch instead of the binary sub-division, whenever /the decimal/ will facilitate his work. The fact that the binary system is commonly used in preference to the decimal is evidence that /the former/ has some advantages. As for slide-rule and logarithmic computations, a short table of decimal equivalents of binary fractions may be printed on the back of the slide-rule, /thus/ eliminating the chances of errors in computing these equivalents.

1/*Ibid*., pp. 658, 698, 699, 706.

"5. Values expressed in any one of the different metric units are translated into values expressed in any other with great facility, and usually by simple inspection; that is, without calculation. For instance, 4 centimètres equal 40 millimètres, or .4 décimètre, or .04 mètre, or .004 décamètre, or .0004 hectomètre, or .00004 kilomètre; and all these relations after a very little familiarity with the system are instantly known almost without mental effort, though in practice the millimètre, centimètre, mètre, and kilomètre only, are generally used. Compare the above with the work required to determine the value of 17/32 of an inch in fractions of a foot, yard, rod, or mile.

"6. The [metric] system provides units of length and of weight adapted to any and every purpose; the millimètre for ordinary machine construction; the centimètre and mètre for building construction, and so forth; and the kilomètre for all other distances, which we now usually express in rods or miles.

"5. The measures of length mentioned here are millimètre, centimètre, décimètre, mètre, décamètre, hectomètre, and kilomètre. The great facility of changing from one of these to the other is not to be compared with the much greater convenience of using fewer units--namely, the inch, foot, and mile--the only three important units universally used in the English system; and the avoidance of errors due to the misplacement of the decimal points. The particular example given ....to express 17/32 of an inch in fractions of a foot, yard, rod, or mile, is one which might be given to a child as an exercise in arithmetical computation, but it [would practically never] be met within a lifetime of experience by a mechanic, machine designer, or engineer....For comparison let us give a practical example in the metric system. What is the side of a square whose area is 10 hectares? Answer, 316.628 mètres.[1]

"6. The English system provides units of length and weight admirably adapted to every and any purpose in measuring; the inch, with its binary or decimal subdivision as may be preferred, for machine construction; the foot for all dimensions in building construction, up to any number of thousand feet (this foot takes the place of the [three] usual French measures mentioned--the mètre, the centimètre, and décimètre); and the mile for all great distances. For measures of length, therefore, the three units--inch, foot, and mile--cover all requirements better than the five units--millimètre, centimètre, décimètre, mètre, and kilomètre. The yard is used as a measure of length only for measuring cloth, just as the aune is used in France. The other English measures of length, which are frequently cited by metric advocates, are either obsolete, obsolescent, or used by a very limited number of people for special purposes.

[1] *Ibid.*, p. 697.

Appendix C1. (continued)

"7. The metric system is now the standard with chemists, physicists, and scientists all over the world, and it is generally conceded that for the work of the scientist this system is far superior to any other in use..../He/ uses it for weighing, measuring, and calculating, which is precisely what machine constructors use it for, and there is no valid evidence to show that a system of weights and measures, which scientists find most convenient, would not be equally so for all other users of it.

"7. 'The metric system is now the standard with chemists and scientists all over the world' because the chemists have found it convenient for their purposes. This is no reason why machinists should adopt it, when it is inconvenient for their purposes. As for scientists using the metric system, this can only be true by giving a very limited definition to the word 'scientist.' The finest scientific work in refined measurements that has ever been done has been done in the machine shops of England and the United States and has been done mostly in the English system. The statement that 'there is no evidence to show that a system of weights and measures which scientists find most convenient would not be equally so for all other users of it,' is opposed to the opinion of the largest users of measuring instruments in the country.

"8. For civil engineers or land surveyors, who now preferably use decimal sub-divisions, the metre forms an excellent base, replacing rods, chains, and so forth, and a convenient series of reduction scales can be derived from it, whereby dimensions or drawings can be readily interpreted by the standard scale. As the weight per unit of volume is derived directly from the specific gravity, the system facilitates the computations of masses of materials.

"8. For civil engineers or land surveyors, who preferably use decimal subdivisions, the foot now forms a perfectly satisfactory basis, replacing rods, chains, and so forth..../Also/ a convenient series of reduction scales (such as 1/4 inch to the foot) can be derived from it whereby dimensions on drawings may be readily interpreted, thus obviating the necessity of translating existing records of land surveys into units, which are entirely incommensurable with our present ones. This fact is most forcibly shown in the provisions of the bill before Congress,1/ which especially exempts the public land surveys from its operation. As to the weight per unit of volume being derived directly from the specific gravity, this necessitates reference to tables of specific gravities of substances, which is no more easy than reference to tables of weights per cubic foot and per cubic inch....In fact, weights per cubic foot are usually more easily carried in the mind than specific gravities--for instance: cast iron; weight 450 pounds, specific gravity

1/See Appendix B, p. 209, for proposed bill.

7.218: wrought iron; weight 450 pounds, specific gravity 7.7: brick; weight 100 to 125 pounds, specific gravity 1.6 to 2....[1]

"9. For all ordinary mechanical drawings the millimètre is well adapted, rarely requiring the use of decimal or fractional figures, and as no symbols for unit measure are needed, the chance for misinterpretation or error is less than with..../the English system/ where feet may be confused with inches and vice versa. Likewise less figures are usually required than with our system, especially where many fractional terms are employed. The misplacing of a decimal point one place makes the result either ten times too large or too small, and such an error is usually instantly detected. If errors should arise from this source, adherence to a few simple rules will avoid them. In Europe the millimètre is usually the only unit employed on mechanical drawings and in machine shops.

"9. For all ordinary mechanical drawings the inch is better adapted than the millimètre; the inch can be used up to more than 100 inches and down to any fraction, binary or decimal, that may be desired; and no symbols for unit measure are needed, if the drawing states that all measures are in inches. The use on a drawing of both feet and inches is entirely a matter of choice with the draftsman or his employer. The statement that 'less figures are required on an average than with our system' has frequently been denied by the heads of the largest shops in the country where both systems have been used....The use of the millimètre as the unit tends, on account of its small size, to increase the number of the figures required on a drawing.[2]

"10. That the /metric/ system is superior to ours for fine toolwork is demonstrated by the fact of its adoption by so many manufacturers of this class here, especially such as produce optical instruments, watches, and so forth.

"10. The production of optical instruments and watches is an exceedingly small branch of manufacture, as compared with that of machine tools....It may be convenient to use the centimètre or millimètre in such work, while the manufacturers of other tools would find it preferable to use the inch. Also, if the optical instrument makers and watch makers have voluntarily adopted the metric system, /this/ is no reason why other manufacturers should be forced to adopt it against their will.

"11. A convenient and expressive series of wire gage numbers can be derived from the /metric/

"11. The use of wire gage numbers is now generally condemned, and is being abolished gradually, /the/ thousandth of an

1/Ibid., p. 703.

2/Ibid., p. 704.

Appendix C1. (continued)

system, expressed in tenths of a millimètre; using only two figures; and the gage numbers expressing the actual dimensions.

inch being substituted. For electrical wiring calculations, the new unit--the circular mil--has been found to be a great convenience. The introduction of a new system of wire gage numbers, the dimensions being in tenths of a millimètre would be a deplorable addition to the existing confusion of wire gages.

"12. [The use of the metric system] would avoid the mixture of decimal and binary fractions now in common use in machine shops.... [This mixture] requires frequent conversion to decimal equivalents or reference to printed tables. For instance, it would entirely avoid such problems as the following: A hole is 1 3/32 inch [in] diameter. A piece is to be turned to fit it with .003 inch clearance. What is the diameter of the latter piece? By reference to a table we find 1 3/32 inch equals 1.09375 inch, and subtracting .003 inch we have 1.09075 inch. A parallel example in the metric system would be: [A] hole [is] 29 millimètres in diameter. [The] diameter of a pin to fit with .06 millimètre clearance equals 28.94 millimètres....The size is thus obtained immediately, without a table, and by mental calculation. In other words, absolute dimensions for fine fits can be expressed clearly and with greater precision than is the case with our system. Therefore much figuring in the shop and in the drafting room.... [would be] saved.

"12. The English system avoids the use of decimal and binary fractions whenever the designer or user of the unit chooses to use either one fraction or the other in his work. For instance, a superintendent of a machine shop wishing to order a pin to fit a hole which is 1 3/32 diameter with .003 of an inch clearance, would, by reference to a table on his desk, or to the table stamped on his micrometer caliper, obtain the diameter of the hole in decimals; namely, 1.094, and the dimension 1.091 equals 1.094 - .003 would be given to the workman, or a gage would be furnished him to work with. In other words, absolute dimensions for fine fits can be expressed in one unit just as well as in the other.

"13. Metric micrometers are graduated to read to .01 millimètre, and all such problems as the foregoing would be readily solved by draftsmen and workmen usually without the use of a pencil, and always without reference to a printed table. Furthermore, .01

"13. If the micrometer reading to .01 millimètre is better than one reading to .001 inch, so also is one reading to .0001 of an inch better than the one reading to .01 millimètre. Such micrometers are in daily use in toolrooms for work requiring this degree of refinement.

Appendix C1. (continued)

millimètre is a better unit than .001 inch for micrometer calipers, because the former is somewhat less than one-half the magnitude of the latter, and .001 inch is too large a unit for the better class of work done in machine shops, as is evidenced by the frequent necessity for dividing the .001 inch, and reading measurements by estimation between graduations on the micrometer.

"14. The [metric] system is so simple that the average workman has no difficulty in learning to apply it in a very short time....The metric hand-rule with the millimètre sub-divisions presents the most convenient minimum sub-division that can be devised. The 1/16 inch on our hand-rule is too large, whereas half of this, or 1/32 inch, is found too small to be clear and legible for ordinary hand-rules. The system avoids the use of our common fractions, which are cumbersome and inconvenient.

"14. The average workman in using the metric system has a more inconvenient rule to handle than the English two-foot rule because the former requires sub-division by tenths, if the mètre is used, while the latter is usually divided into four parts. The ordinary two-foot rule often contains on one side tenths of an inch, and on the other side sixteenths. If twenty-fifths of an inch were wanted, they would be put on it, but the average workman finds no difficulty in splitting the sixteenths by eye, and reading by thirty-seconds. On steel scales sixty-fourths of an inch are quite legible.

"15. In applying the standard [metric] scale for measurements the user is not hampered by preserving the distinctions between inches, feet, and so forth, or [by] referring to the corresponding symbols. The measurement is simply read off and the terms referred to in any sub-division of the mètre that is convenient and desirable, just as we do in reading our Arabic numerals.... The significance of these is readily grasped by men of ordinary intelligence.

"15. In applying the standard two-foot rule, the user deals only with inches, unless he chooses to use feet. The choice of the two units is a great convenience....He should not be deprived of it, since it presents a simple picture to the mind for mental conception of the required or existing dimensions.

"16. The use of the metric system would not require the alteration of established standards, such as bolt or pipe threads, taper shanks of drills, and so forth. In fact, in many standard articles dimensions are only nominal, and not real. In

"16. The statement that 'the use of the metric system would not require any alteration of established standards' can only be true by giving a very limited definition to the word 'use.' If the United States is to adopt the metric system it will have to adopt metric

all such cases integral metric figures could readily be applied to these, which would be at least as near as the existing nominal dimensions are to the actual.... No change of actual dimensions would be required, and for ordinary use such standard articles would probably retain their present names or designations. No law could prevent this.

standards; that is, we would have a standard size of mandrel, whose dimension is 25 millimètres, for the manufacture of new machines, and we would also have a standard one inch mandrel, which we might call 25.4 millimètres, for repair work on old machines. But if the word 'use' means simply that we are to continue to work with existing standards, and merely call them by metric names, we submit that this is not either the adoption or the use of the metric system....It simply introduces unnecessary complication and confusion to attempt to express an existing standard dimension, which is exact in the English system, in terms of the metric.... with which the English system is incommensurable....In the case of a one-inch mandrel, would it be right to call it a 25 millimètre mandrel, when its true dimension is 25.4, and when there is also another 25 millimètre mandrel made to the French standard kept in the same tool-room? So also would the two-inch mandrel be called a 50 millimètre mandrel, or a 51 millimètre mandrel, which is the nearest integral figure? In regard to bolt or pipe threads, taper shanks of drills, and so forth, which are referred to, these are standardized to the .001 of an inch. In such cases integral millimètre figures could not properly be applied to them....[1]

"17. The expense and confusion incident to making the change are usually much over-rated, as it is now known by actual experience that the two systems can be used concurrently with little confusion in the same establishment....Any changes of dimensions that might be desired for expression in integral metric units could be effected from time to time as the opportunity offered. All shops are constantly wearing out or renewing tools, gages, and so forth, and at the proper time these can be replaced to conform in

"17.../The first/ statement can only be met with a positive denial. It is the overwhelming testimony of the largest manufacturers in the country, that the expense and confusion of making a change cannot be stated emphatically enough.... /In regard to the second statement/, when would the opportunity be afforded to change the shape and size of a milling cutter, adapted to cut teeth of six pitch....(six teeth per inch of diameter) of a gear wheel, to adapt it to any integral metric unit? Of the hundreds of thousands of matched gear wheels of standard diametral pitches, which are now in use, how is it possible to reproduce these

1/Ibid., pp. 680-684.

Appendix C1. (continued)

absolute dimensions to the metric units. The weight of evidence on record indicates that the change is actually made with less trouble and expense than is anticipated by those, who oppose the system.

in any integral metric unit, or effect this transformation without tremendous confusion? When will the proper time come to abandon every one of these gears, and replace them with others, which 'conform in absolute dimensions to the metric units'? The same applies to all screw-thread standards, pipes, bolts, turned shaftings, and so forth, and to all standard shop sizes.1/

"18. To the public at large the [metric] system offers the advantages of definite and convenient units of weight and volume. The conversion from one unit to another of the same class is effected by a simple mental process, without calculation, or reference to tables, or any severe tax on the memory. Its adoption would abolish the conflicting units of weight and volume now so prevalent, and would bring all our standards of weights and measures to a simple expressive basis. Its adoption would tend to abolish the pernicious practice of selling products by the 'basket' or 'box,' or other measures of unknown capacity--a practice which encourages fraud. This result seems to follow where the system has been adopted.

"18. The alleged ease of conversion from one unit to another (of weight and volume) exists only in reference to distilled water. For all other substances tables must be used to show either the specific gravity in the metric system, or weight per cubic foot or per cubic inch in the English. To the public at large the English system offers the advantage of definite and convenient units of weight and volume. The cubic inch, cubic foot, and cubic yard are all that are needed to express volumes, [while] the pound is all that is needed to express weight. But the weight of any given volume of any large number of materials, except distilled water, cannot be memorized by any ordinary man.... he must refer to tables of weights or specific gravities to obtain the weight ....The pernicious practice of selling products by the basket or box....can be abolished at any time, without adopting the metric system, by the simple expedient of selling all boxed or basketed goods by the pound; or else by enacting laws to prevent the use of fraudulent measures, boxes, or baskets, which do not represent known measures of volume. Thus, let the law provide that a quart box of strawberries shall actually contain a quart, or a definite amount by weight.

"19. The testimony of those, who have used both the metric and the English systems of measurements in machine construction and in

"19. The testimony of those who have used both systems is by no means entirely in favor of the metric....There are many witnesses on the other side....2/

1/Ibid., pp. 711, 712.

2/Ibid., p. 705.

other industries, is largely in favor of the metric system....

"20. The standard terms for metric measures can be readily abbreviated into terse words or monosyllables, adapted for popular use, but retaining the significance of the original. The adoption of the metric system would not involve much recalculation for standard technical tables, and so forth, as the French and German technical literature of this kind is quite complete....It would be necessary merely to reprint these tables.

"20....The French people in a hundred years have not adopted such short terms. Can any terms be better than our foot or mile?....Will the writer kindly exemplify /the second sentence/ by producing a table which corresponds to that....of lap-welded pipe....issued by all the pipe manufacturers of this country? Or, will he furnish a table showing the flow of water or steam in pipes of the existing American standard dimensions....The substitution of the tables in French and German technical books for those in English books will only be possible when all our standard sizes are the same as the French and German....that is, when we no longer have pipes, bolts, and so forth, of even inches and binary fractions of an inch, but have /those/.... which increase in size (nominal diameters) by two to ten millimètres per size....[1]

"21. With the /use of the/ metric system the necessity of binary division largely disappears. Halving and quartering might be used as popular expressions, but the decimal fractions only would be used in technical literature. Binary divisions may, however, be used, as they sometimes are with our coinage.

"21. The binary division could be dispensed with also in the English system, if it were thought advisable, which it is not. A dimension of 1 1/16 inch gives a clearer mental conception than its equivalents 1.0625 inch and 41.3 millimètres. It is inadvisable, also, to have the expressions in technical literature different from those in common use, as much of our modern technical literature is written for the ordinary workman.... 'It is desirable that all drawings should be as large as they can conveniently be made or read'....Therefore, a scale or proportion of the full size must be used as 1/2, 1/3, 1/4, 1/5, 1/6, 1/8, 1/10, 1/12, 1/16, to which the divisions of an inch on our rules are conveniently adapted. The 1/8 size is very common, but the 1/12 and 1/16 are so small that they are seldom used. The mètre with its decimal divisions affords no such facility. We are therefore confined to 1/2, 1/5, 1/10, 1/20, 1/50 of the full size, so that we have but three practical scales in the

1/Ibid., pp. 691-695, 703, 712.

Appendix C1. (continued)

metric system, where, within the same practical limits, the inch base affords seven. The scale series most common upon the inch base is that of 1/2, 1/4, and 1/8. This halves down from whole size, or can be raised in rapid drawing, by taking off dimensions with the dividers and doubling them, or by using diameter sizes from one drawing as radius dimensions in the other, a process impossible between the 1/2 and 1/5 sizes of the metrical scale....1/

"22. It is generally acknowledged that, if our existing systems of weights and measures should be retained indefinitely, they should be entirely revised and codified to remove the existing inconsistencies and conflictions. The disturbance necessary to accomplish this result would go far toward giving us a coherent and logical system which would be in accord with that of the rest of the world. It is almost certain that the [metric] system is annually gaining strength, both here and in Great Britain and the British Colonies. The evidence obtainable seems to point that way. The resolutions of technical and trade associations and the foothold it now has before legislative bodies indicate this; and it seems not improbable that Great Britain may anticipate us in the adoption of the system.

"22. We are glad to agree with this first statement. It would be a good thing if the British Parliament and the United States Congress should pass a law defining the terms used in the English system, so that no two units, differing in dimension, should have the same name....Against the growing strength of opinion as shown by resolutions, and so forth, in favor of the metric system we have to show the far greater growth in practice with the English system, due to the rapid growth of population, wealth, and industrial pursuits in English-speaking nations; the building of railroads, shops, and so forth; the general tendency to standardization of sizes (based upon the inch) of articles of manufacture and the tools for making them; the spread of technical education, correspondence schools, and so forth; and the ever-increasing mass of technical literature, based upon English standards....The metric system was formally legalized by Great Britain in 1864, and by the United States in 1866. A British Royal Commission, appointed in 1866 to consider the subject of weights and measures, presented five reports between 1868 and 1871. The second report recommended the substitution of the metric for the Troy weight in the mint; its permissive use in customs and other places; and its general encouragement, but that in no case should compulsion be used, believing that the owners of factories

1/*Ibid.*, p. 704.

Appendix C1. (continued)

and others, who might desire to use it, could arrange such matters without legislative assistance....This is as far as Great Britain has as yet gone toward the 'adoption' of the system. The Weights and Measures Consolidation Act of 1878 reaffirmed the existing standards, again making the metric weights and measures permissive. If 'adoption' means compulsory enforcement, then Great Britain is a long way from the adoption of the metric system. That this country will ever 'adopt' the system in this sense, whether anticipated or not, is doubted even by its advocates....[1]

"23. The retention of ancient units of measurement in popular phraseology, or in exceptional industries, has no force as an argument against the metric system, since this merely illustrates a well-known trait of mankind, where tradition or force of habit tends to maintain ancient or obsolete terms or usages in a rudimentary form. This was exemplified with our monetary units. Ancient and objectionable units remained in use for a generation after the adoption of our decimal currency. Roman numerals are still retained on watch faces, title pages of books, and so forth. The Gregorian calendar has not yet entirely displaced the Julian throughout the civilized world. Yet no one could effectively maintain that the abandonment of these ancient systems was unnecessary and effected no useful purpose...."

"23. Possibly it is not an argument against the metric system *per se*, but the 'well-known trait of mankind where tradition or force of habit tends to maintain ancient or obsolete terms' is a powerful obstruction to the general introduction of the system, and it may be used as an argument to show why the people of the United States are no more likely to adopt the metric system than they are to adopt the French language."

1/ *Ibid.*, pp. 686-687.

Appendix C1. (continued)

Then follow in the report anti-metric arguments together with pro-metric replies. They are:

"Argument against the Metric System."

"I. ....In the metric system there are seven fundamental units; that is, the mètre, the square mètre, the are, the cubic mètre, the litre, the stère, and the gramme. The subdivisions are expressed by the seven prefixes--milli, centi, déci, for the smaller dimensions, and déca, hecto, kilo, myria, for the larger dimensions..../Thus there are/ 56 possible combinations.... /30 of which are in common use, and/ nearly all of them are expressed in polysyllables. The English system has 19 units in common use. Nearly all of them are expressed in monosyllables, and every one of them is familiar to every English-speaking school boy twelve years of age. Their values are definite....1/

"Replies to Argument against the Metric System."

"I. The number of fundamental units for weights and measures used in either the British or the metric system has little, if any bearing upon the respective merits or demerits of the two systems. The essential difference is, however, that in the British system the complex relationships of the various denominations are such that they are interconvertible only by calculation, whereas in the metric system no such calculation is required, as they are interconvertible by inspection; because the metric system....'harmonizes with the world's arithmetical notation'....In ordinary metric measurements, such as are used in machine construction, and so forth, it is neither necessary nor customary to name the units that are expressed numerically. The figures carry their own significance; for example, if a dimension is 1245 millimètres, the speaker usually says twelve-forty-five without any reference to the special unit intended, which is always understood ....Therefore....abbreviations for utterance of the terms are not of much importance, as the terms themselves are so little used. This is in marked distinction to our system, wherein the terms have to be constantly employed to preserve the distinction between feet, inches, and so forth....As the relations between the denominations are simple, clear, and expressive the small units of weight are more frequently used in the metric system by people of average intelligence than is customary with us.... The smaller units of weight in our system are obscure to the great

1/*Ibid.*, pp. 658, 660.

Appendix Cl. (continued)

majority /of people/. The misinterpretation of drawings, by occasional confusion between feet and inches, is an old and never-ending source of trouble in our system. The attempt to obviate it by making all numerical terms on drawings in inches, has proved equally unsatisfactory, as, when measurements of several feet are involved, the workmen must make the conversion by calculation, thus introducing another source of possible error. This difficulty is absolutely avoided in the metric system....

"II. No matter what system may be used, any given industry or trade will employ only those units of measurement, which are convenient for its work, and will usually dispense with the others. It is, however, obviously an advantage to have all terms of measurement used by others readily convertible into the terms or units with which one is familiar by reason of daily use. This advantage is secured by the metric system, but it is not secured by the British. If, however, a fewer number of units is considered an advantage....then the metric system will easily stand fair comparison with the British on that score. The comparison, as made, however, is most unfair to the metric system, especially so far as it applies to the machine-building industries, because, in machine construction, dimensions in whole numbers of inches are very rare. Also in fairness the fractions 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, and .001 inch should be added to the list of British units, because all these are in common use in machine shops. On the other hand, .01 millimètre should be added to the list of metric units because it, too, is used in machine construction. When these additions have been made, we find that in the English system

"II. ..../Many of the ancient English measures are obsolete or obsolescent,/ and only used by a small fraction of the population engaged in special trades.../Therefore/nineteen terms.... are all that are really needed by the English-speaking races for all commercial and manufacturing purposes.

there are nine different units commonly employed in machine construction, and only two, or at most three, in the metric....In practice, also, the square inch and the cubic inch have often to be divided into fractional parts; much more frequently so than the square centimètre and the cubic centimètre, because the former are much larger units....The chain and the link are still commonly used in all farm surveys; the foot and the hundredth of the foot in city surveys and in leveling. These are used because surveyors and engineers find the decimally divided unit much more convenient both in field work and [in] computation.

"III. Mental conceptions of the dimensions of units come with experience in the use of any system, just as one learns to think in any language with which he is familiar. The mental conceptions, however, are more easily obtained and preserved with the metric system than with ours; as the denominations have a uniform relation to each other, and are expressed in numerical order. The difficulty of acquiring the mental conception referred to is frequently commented upon by those who have been accustomed to metric measurements and are unfamiliar with the British.... [The latter is complex] as compared to the simple, expressive metrology of the former....

"III. ....[English units are more convenient.] The four measures of length are familiar to the English-speaking race the world over, and a mental conception is immediately formed whenever one of them is mentioned. The yard is practically obsolete for all purposes of linear measurement except in measuring cloth and yarn. The sizes of these units are entirely satisfactory, or at least they are more satisfactory for practical purposes than the metric units. As for square measures, the square inch, square foot, square yard, and square mile are entirely satisfactory units and much more satisfactory than the six in the French metric system. The acre is not a satisfactory unit, and in course of time it may be abolished, its place being taken by some even multiple of the square foot, as already obtains in city land measurements. As to the measures of volume, the cubic inch, foot, and yard are really all that are necessary for a good system of measurement, but the quarts, gallons, and bushels are convenient sizes used in commerce. The three units of weight, ounce, pound, and

Appendix Cl. (continued)

ton, are entirely suitable for the ordinary uses of commerce. The grain is practically not used, except in druggists' prescriptions. The objection to the different kinds of English tons is not an objection to the English system _per se_; at any time the ton of 2,000 pounds may be made the legal ton for buying and selling. For chemists' purposes the metric system is in common use, and is entirely satisfactory, but for ordinary purposes of weights the English system is superior, in having a smaller number of terms and in the sizes of units being more suitable for commercial uses. The accurate or scientific measurement of the length of a bar or of a land boundary, may be done equally as well in the metric as in the English system. So the accurate weighing of a body of unknown weight may be done on a chemist's balance equally as well in one system as in the other. But such measurements and weighings form an exceedingly small fraction of all.... /those/ done in commerce and the industrial arts. The more common measurement is to lay off a given dimension, which is marked on a scale. Thus the carpenter with his two-foot rule lays off on a plank to be cut, the dimensions 8 feet long by 6 inches wide; the iron roller makes bars 1 inch in diameter, and cuts them off 16 or 20 feet long..../In like manner does the machinist, the cloth manufacturer, the grocer, and the druggist./ For all such measurements and weighings, which constitute probably nine-tenths of all..../those/ in the world, the English units are superior to the metric....and the binary system of subdivision is superior to the decimal. The foot and inch are more convenient than the mètre and its decimal subdivisions, and the binary system of division is so necessary for the needs of the common people that it is quite commonly used in metric countries. If a man wants to divide a mètre into any other binary division than halves,

Appendix C1. (continued)

"IV. There is no foundation for the assertion that it would take at least two generations for the English-speaking race to learn to think in the metric system. It was accomplished in Germany within a few years, and we have many illustrations of a similar character; for example, our own change of currency, and the change to a decimal currency in Canada, which /latter/ was made with hardly a ripple of disturbance. The printers have changed their entire system of type measurements without confusion....The mere fact that the use of ancient terms and units continues in certain industries or in communities, isolated in thought and habit from the major ranks of society, carries no more weight than does the fact that we still retain Roman numerals on our watch faces, and so forth. A large number of the articles enumerated would require no immediate change other than that of name, until such time as they may be superseded by new tools or articles of the desired absolute dimensions. Old tools and appliances are continually being displaced by new, and now more rapidly than at any previous period....Integral metric units can be applied to both external and internal diameters of our standard tubes, which are at

quarters, and eighths, he cannot do it on a mètre scale without splitting a millimètre, and making an approximate measurement, while on an English scale he can divide a foot into thirds, sixths, twelfths, and twenty-fourths, as well as into binary divisions as far as sixty-fourths (if the scale reads to 1/16 of an inch), and he can divide an inch on a machinist's steel scale as far as 1/64 of an inch.

"IV. A serious objection....to the introduction of the metric system is that all the English-speaking race think in the English system. The attempt to make these people do their thinking in the metric system would be the work of at least two generations, during which time there would be endless confusion and an enormous waste of mental effort in trying to keep the two systems side by side. All the literature in mechanical science and engineering in the English language, which has accumulated in the past hundred years, would be practically unreadable until translated into the new system, if people are compelled to do their thinking in the metric system. In the expressed opinion of business men of great experience in manufactures, it would retard the development of manufactures of the United States at least twenty-five years, and be practically at the cost to the country of its present prestige. Let anyone take one of the engineers' pocket-books and attempt to re-write a few pages of it, especially those involving formulae, such as the formulae for flow of water and flow of steam, expressing all the units in the French system; and then show the result to a friend, and ask him to form a mental conception of the dimensions therein expressed; and he will get a realization of the enormous amount of effort needed to change the reference books into the French metric measures, and the still greater effort to comprehend them after they are so changed....1/

1/Ibid., pp. 681-685, 691-697, 702, 705.

Appendix C1. (continued)

least as close, if not closer, to the actual dimensions than those given on our tables, and for the flow of fluids our terms have merely to be translated into the metric measures. This whole argument....is largely a case of imagined difficulties.... which, it is almost universally declared by those who have tried the metric system in actual work, do not exist, or are much less serious than one, who has made no trial of it, is apt to imagine.

"V. ..../Those who have used the metric system have/ failed to discover the difficulties named ..../or have/ found it very easy to overcome them....The British system is satisfactory to those who have been given no opportunity to familiarize themselves with a better. Its use, like many other objectionable habits, has been imposed upon us by inheritance, and it can be eradicated only by an effort. We respectfully submit that a practical trial is the only way by which reliable evidence in such matters can be secured. The people to whose evidence we refer have made such trials, and therefore know what they are talking about. They could have no possible object in misrepresenting the facts as they have found them, nor in deceiving others in regard to them, even if they were men, who were capable of consciously doing such a thing."

"V. The whole literature of mechanical science and industrial art in the English language contains the inch as the basis of measurement of length, surface, and volume. Also in Great Britain and the United States, for all ordinary purposes there are based on the English inch:

All rules, tables, and formulae used in calculations, involving measures of length.
All drawings of manufactured articles.
All measuring scales and measuring tools, calipers, verniers, and so forth.
All drills, taps, reamers, screw-threads, boring bars, milling cutters, mandrels, standard plugs and rings, and shop tools, gages, templets, and so forth, that are based on this standard unit.
All machine tools, leading screws of lathes, and feed and elevating screws of milling machines, planer heads, and so forth.
All graduated heads of feeding screws.
All interchangeable parts of the things made in machine shops which things are distributed all over the world.
All gear wheels, gear cutters, and gear patterns.
All pulleys and shafting, hangers, couplings, bushings, and bearings.

Appendix Cl. (continued)

All merchant sizes of bars and plates of iron, steel, and other metals.
All structural iron shapes.
All merchant sizes of pipe, pipe flanges, pipe fittings, valves, and the screw-threads of the same.
All bolts, nuts, rivets, and keys.
Locomotives, cars, railroads and their appurtenances, all marine and stationary engines, all ships.
All parts kept in stock for repair or replacement of these things....

"[There are more of] these things in use throughout the world, produced by the shops of the United States and Great Britain....[than there are of] similar things produced, based on all the other systems of measurement, in all the rest of the world combined....[There are more] people engaged in making these things in the United States and Great Britain....[than there are] people engaged in making similar things in all the rest of the world combined....[There are more] people using these things throughout the world....[than there are people], who use similar things, based on all other systems of measurement combined. Every Anglo-Saxon mechanic and draftsman in the United States and Great Britain (in watch and optical instrument factories possibly excepted) thinks in the English system. The common people in these countries universally think in this system. To the English-speaking mechanic the English system is a perfectly satisfactory one. Every technical paper and book he reads, or refers to, uses that system. For him to change from one system to another would be worse than for him to have to learn a new shop language. He might, with much effort, learn a thousand new words, and accustom himself to use them instead of their English equivalents, but in his use of the metric system he would have to compute either mentally or on paper every time he had to compare a measurement in English with one in the French

system or vice versa. If he were given a metric measurement he would have to translate it into English to get a clear mental conception of it. If the metric system were adopted in this country, the next two generations of mechanics would have to learn both systems, and to think in both....[1]

VI. No reply.

"VI. ....'The abandonment of the inch will involve the destruction of our existing standards....The chief value of a standard lies in the fact that it is adopted; that it has become part of our daily lives....Because the threads are standardized, pipe fittings can be made by the million, at trifling cost, and that when we need a fitting we can buy it for a few cents with the assurance that it will fit instead of having to get it cut to order to suit an odd size of thread'....[2]

"VII. Commenting upon the alleged simplicity of the British system, our confreres again omit to add the six usual binary divisions of the inch from 1/2 to 1/64 inch inclusive, which are practically all independent units, and in the metric system are replaced by the single unit, the millimètre, and its decimal division .01 millimètre. The mere assertion of superiority for these units is far from convincing to those, who do not use them, or to those who have learned to dislike them. The practically universal testimony of those, who have used both the metric and the English systems, is that the former is very much the more simple and convenient in every way. We prefer to take the testimony of those, whose opinions are

"VII. ....[The English system is simple. Only fifteen fundamental and universal units] need be used in computations by the mechanic and engineer....[Even this number] may easily be reduced, for mechanics and engineers scarcely ever use the yard or the square yard. The cubic yard is used as a measure of earth and rock, by old usage, but a new unit of 100 cubic feet might with advantage be substituted for it. So also the ounce and grain might be abandoned, and decimal sub-divisions of a pound used instead. The mechanic and engineer would then have only nine fundamental units to memorize....[3] These nine units form a system superior in every way to the metric system. Any one of them may be used with binary or decimal subdivisions as desired. The inch is a more convenient unit than the millimètre for the mechanic and the draftsman. The foot may conveniently be used

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1/Ibid., pp. 691-697, 702, 703, 706.

2/Ibid., pp. 672, 699, 708, 709, 711, 712.

3/Ibid., p. 674.

based upon actual experience with both systems, and who are, therefore, in a position to draw comparisons, based upon actual working knowledge of both systems....

by the engineer for any distance from .001 to several thousand feet; and the mile being used only for long distances, as on roads or on the sea. The square foot may be used for large as well as for small areas as we speak of a floor or land area of 20,000 square feet. The cubic foot is a most useful unit both for solids and liquids. The names of all of these units are monosyllables, and differ greatly in sound; while those of the metric system are mostly polysyllables, many of them similar in sound, and derived from the Greek and Latin languages. A few other units may conveniently be used for certain purposes, such as: the mil (.001 inch) and the circular mil for electrical wiring calculations; and the acre or 1/640 of a square mile, since it is 'irrevocably tied to the past' in our land surveys. The importance of retaining our existing measures of land is recognized in the bill now before Congress. Certain other units will be retained, not because they are necessary, but because they are in universal use, such as the bushel (2140.52 cubic inches) and its binary sub-divisions for measuring grain; and the gallon (231 cubic inches) and its binary sub-divisions for measuring liquids....The yard will necessarily be retained for measuring textile fabrics and yarns, because it is in use in the textile trades all over the world. Three-quarters of all the cloth sold in the world is sold by the yard. It is used in the manufacture of cloth even in France. The carat, a special unit for weighing diamonds and other precious stones, equals 3.168 grains, or 0.205 gramme, is in universal use all over the world, and no useful purpose would be served by abandoning it. Troy weight ....is used only for weighing precious metals, and Apothecaries' weight.... (the ounce and the grain being the same in both) is used by apothecaries and physicians for prescriptions only. Both Troy and Apothecaries' weight might be abandoned.1/

1/Ibid., pp. 685, 690-691, 705, 707.

Appendix C1. (continued)

"VIII. This again is a mere statement of opinion, which is by no means borne out by the testimony of those, who by reason of experience, are competent to give reliable testimony.

"VIII. The English system is per se a better system than the French in that it has:

"1.) A smaller number of units (when the obsolescent units are discarded).
"2.) The dimensions of the units are more convenient for most purposes of measurement.
"3.) The binary sub-divisions are more convenient and more quickly comprehended by the ordinary mind than the decimal sub-divisions of the French system.
"4.) The names of the units are more easily memorized.
"5.) The two units of length, inch and foot, and the binary sub-divisions of the inch give a clearer mental picture to the average man than the numerous units, with their prefixes....based upon the metre. The English system has had centuries of use with no tendency to change the dimensions of the fundamental units: inch, foot, yard, and pound. The English foot and inch are fixed in existing measuring instruments, gages, tools, patterns, machines, machine products, [and] buildings, and [have been] fixed in the literature of the language for centuries. They are 'irrevocably tied to the past.'

"IX. This statement is not borne out by the records. It is quite certain that the metric system is fast gaining ground, and it is universally believed by those, who have given the matter impartial consideration, that the metric system is the only one that has the least chance of ever becoming universally used by all the nations of the earth.

"IX. The people who use the English measures of length in manufacturing are more, [numerically], than those who use the metric measures. Their number is increasing more rapidly. The English race is increasing in numbers and in wealth at a greater rate than any other race [because] the Anglo-Saxons are the great colonizers. The use of their language is becoming more common throughout the world; its use is growing faster than that of any other language. The English language is more likely than any other to become the universal language of commerce--the one language which every educated person will have to learn. The English system of measurement is an indestructible part of the language.1/

1/Ibid., pp. 702, 703.

Appendix C1. (continued)

"X. We do not believe that Congress can by law invade the rights of the people to use any system they may prefer, and we do not believe that anyone thinks of doing such a thing. As to the difficulty of making the change we must again refer to the testimony of those who have made the change, and who say that it is not as difficult as [is] usually imagined and that it results in no serious disturbance or expense....The 'transition period' referred to as a dreaded anticipation is already here, inasmuch as the metric system is now used in our scientific work, and [in] a not inconsiderable part of the industrial work of both this country and England. It is more frequently used in our technical literature than formerly, without the addition of the corresponding terms in British units. These facts indicate that we have begun the adoption of the system."

"X. 'The change of the method of measuring lengths from the foot and inch system to the metric system is utterly impracticable and visionary. If any body of law-makers, such as our Congress, should inflict such a burden upon the people without their consent, it would be the greatest invasion of the liberties of the people, which has ever been attempted by a representative government'1/....In conclusion, we desire to express our opinion in addition to the arguments submitted above, that in view of the testimony and experiences cited:

> The metric system, with all its alleged advantages, comes far short of meeting the requirements of a practical system for universal adoption....
> Intrinsically it is not as good as the English system....
> The exclusive adoption of it by the English-speaking race is impractible."2/

Appendix XII of this report gives the questions, which the Franklin Institute Committee on the Metric System circulated among the manufacturers of the United States, together with the answers given by the Cincinnati Manufacturers in concerted action. These and the pro-metric replies are as follows:3/

"1. Is it not desirable to simplify and change the system of weights and measures at present in general use in this country?"

Pro-metric

"The answers to these questions.... made by concerted action of the manufacturers named, are based almost, if not entirely, upon the paper of F. A. Halsey, which had been previously read at the Cleveland meeting of the Machine Tool Manufacturers' Association....At the Cleveland meeting referred to there was no one to say a word on the metric side, and

Anti-metric

"It is desirable to simplify the present system, if it can be done without introducing more confusion than is saved, which we doubt. It is not desirable to change the system."

3/Ibid., pp. 697-701.

1/Ibid., pp. 678, 709.

2/Ibid., pp. 701, 702, 706, 707, 710, 711.

the fact is that a very large majority of those, who signed the answers as given, did so without having given the matter any serious study or consideration....We feel certain that, owing to the peculiar manner in which this action was brought about, it should have no more weight than Mr. Halsey's paper itself, which is entirely one-sided, and does not profess to be an impartial examination of the question...."

"2. In view of the fact that the following countries officially and customarily employ the metric system of weights and measures--namely, France, Germany, Austro-Hungary, Norway and Sweden, the Grand Duchy of Finland, Holland, Belgium, Switzerland, Spain, Portugal, Italy, Servia, Roumania, Bulgaria, Greece, the Ottoman Empire, Japan, China (thirty-eight ports), Egypt, Mexico, the Central and South American countries, the dependencies of the above mentioned countries, and the Latin acquisitions of the United States--do you not consider that it would be advisable to adopt the metric system in the United States with the view of bringing about international uniformity in weights and measures?"

Pro-metric

Anti-metric

"The statement that the countries named 'customarily employ the metric system' is a pure assumption. No evidence of this is submitted, while, on the contrary, all available evidence shows that in some of these countries the system is used but little, and in none of them is it universal. Even in France, the old units are still in wide use. Considering the age of the system, this is sufficient proof that it cannot become universal, and all arguments, based on the assumption that it can be, fall to the ground."

"3. Would not the introduction of the metric system benefit the foreign trade of the United States?"

Pro-metric

"[This argument is] somewhat puerile. The machines referred to were accepted by customers with only the adjusting and measuring screws made metric, because at that time; namely,

Anti-metric

"Of the millions of dollars of machine tools which the members of the Association have sold to France and Germany, the great majority have been sold without request or suggestion that any

two or three years ago, the demand was very active, and the buyer accepted what the manufacturer was willing to give him; but conditions have changed a great deal in Europe, and a large number of tool users now buy German tools, when they used to buy American....simply because the former are manufactured thoroughly to the metric system."

of the dimensions be made in accordance with the metric system. The only changes that have been asked for have been in occasional measuring and adjusting screws. In view of this experience and of the unexampled growth of the export trade of this country during the past half-dozen years, we cannot see any need of changing for the benefit of foreign trade."

"4. Do you not consider that the introduction of the metric system would facilitate and abbreviate the computations, which present themselves in the ordinary occupations of life?"

Pro-metric	Anti-metric
	"Theoretically, yes, though to an extent that has been grossly exaggerated. The supposed gain, considered in its economic value to the nation, we consider to be trifling. Moreover, this trifling gain is dependent upon the old units becoming extinct, which in France and Germany they have not done. On the other hand, the existence of both old and new units in those countries serves in many instances to increase the labor of calculations, and to nullify the whole argument, based on the theory of the metric system."

"5. Would not the introduction of the metric system, by practically limiting the units of weight and measures to:

(1) The mètre
(2) The gramme
(3) The litre
(4) The are;

and in view of the simple prefix system of decimal multiples and submultiples existing in that system, assist in measuring and expressing quantitative values of all kinds?"

Pro-metric	Anti-metric
	"Should the old units become extinct, yes; but the experience of metric-using countries shows that they will not. The adoption of the system will thus add to the number of units to be learned."

Appendix Cl. (continued)

"6. It has been found upon investigation by the Bureau of Education of the United States and the Select Committee on Weights and Measures of the House of Commons of Great Britain that a year of the school life of children could be saved through replacing the customary weights and measures by the metric system. In view of this fact (?) is not the change to be desired from an educational standpoint?"

Pro-metric	Anti-metric
	"This conclusion is also based on the theory that the old units will become extinct. If the old units are to continue, as all experience shows they will, the conclusion is nullified and reversed--the children will have an additional system to learn, and their labors will be increased, not diminished."[1]

"7. What length of time do you think would be required to instruct artisans in the use of the metric system?"

Pro-metric	Anti-metric
	"The experience of France has shown that the change cannot be completed in a century. In view of this, we regard what anyone 'thinks' about the matter as of no importance."

"8. Would the fact, that in the decimal system continued fractional subdivision by 2 cannot be conveniently carried so far as in the customary weights and measures with common fractions, seriously militate against the introduction or use of the metric system?"

Pro-metric	Anti-metric
	"We consider the advantage of the binary system of division to be too important to be dispensed with."

"9. If the metric system were adopted within a few years in your business, would its gradual adoption entail great expense? How could this expense be minimized or avoided?"

Pro-metric	Anti-metric
"There is no doubt that the metric system will be exclusively used the world over some day, even in the United States, and it would	"To adopt the metric system gradually would involve making machines for years with part English and part metric dimensions, with constant change as the

[1] Ibid., p. 706.

Appendix C1. (concluded)

seem....that since the American tool manufacturers will have to make the change from the English system to the metric, it would not cost them any more now than later, and of course the sooner the better for them, since, when their European trade is lost, and in the hands of their German competitors, it is doubtful that it will be easy to secure it again."

English dimensions are dropped--that is, until the transition is complete. During this period there could be no standardized production, but constant change. We cannot regard the use of both systems on the same machine as a thing to be tolerated, much less encouraged. To continue existing units on old machines, while adopting the metric units on new ones, helps matters but little, as in all lines of machines many parts are common to different sizes. Moreover, the whole question is based on the idea that the sacrifice of the change is measured by the cost of buying new small tools. On the contrary, the chief sacrifice is in the changing of standardized things--in the throwing away of standards, the value of which we will not know until we lose them....Into the loss due to the destruction of standards the element of time does not enter, and we, therefore, regard the idea of a gradual change as simply postponing and refusing to face the difficulties of the problem."

"10. Are you in favor of the bill, H.R. 123, as reported from the Committee on Coinage, Weights, and Measures, which, it is expected, will be considered at the coming session of Congress?...."

Pro-metric	Anti-metric
	"No. We believe that the difficulties of the change have been ridiculously underestimated, and that the metric system offers no compensating advantages. We regard the whole matter as a shop affair exclusively, since the confusion and expense must be borne by the shops. We, therefore, regard the intrusion of those, who have no pecuniary interest in shops, as unwarranted."

Appendix C2. Summary of Report Number 42 of the National Industrial Conference Board

The question dealt with in this report is, "Shall the metric system be substituted by compulsory law for the English system of weights and measures in the United States?" The research was done in connection with the proposed Ladd [1] Metric Bill, S.2267. The writer has summarized parts which supplement Report Number 972 of the American Society of Mechanical Engineers.

"In Part 1 a picture is drawn of the national or governmental status of weights and measures."[2] The origin of English and other natural systems is discussed first. It is pointed out that "standards of weight and measure have been recognized since very early times as essential to the development of the commerce, industry, and social life of nations..../Primitive man used/ rough natural units..../but/ with the progress of civilization came the need of uniformity in the common units used..../and/ the need of subdivision, extension, and coordination of these fundamental units..../which resulted in/ the development of systems of weights and measures. Any uniformity thus obtained was first local..../then/ national..../and/ through trade intercourse....international....in certain instances."[3]

The earliest known systems were those of the ancient Eastern kingdoms. It is believed that all other systems, except the metric, have descended from these, "because of certain resemblances to such modern systems as the English or Spanish....All natural systems in existence today have many of the same characteristics, and several resemble one another so closely as to suggest a common origin..../Units of length, particularly short ones, are of fundamental importance, because/ machinery, buildings, various kinds of permanent equipment, and land areas are closely bound up with these units.... and stand for a relatively long period as embodiments of /them/..../The short units of the primitive systems, developed in Egypt, Babylonia, China, Rome, and Greece, were all based/ on lengths of portions of the human body, or upon the sizes of familiar natural objects such as seeds. Most commonly, in measuring small distances primitive man would take the length of his foot, or the breadth of his hand as the unit."[4]

English measures and weights originated in prehistoric times, introduced possibly "by the Phoenician traders, and afterwards modified by the Romans, Saxons, Scandinavians, and Normans each of whom had measures based on the old units..../The Greek and Roman systems/ were probably most influential in forming the English....The most important early English legislation was contained in Magna Charta (1215), which laid stress upon the principle of uniformity....The Anglo-Saxon measures of length down to the present have remained on the same basis as is given in the statute of Edward II (1324)..../which stated/ that 'three barley corns, round and dry, make an inch; twelve inches a foot; three feet a yard; five and one half yards a

1/See Appendix B, pp. 209 - 211 , for proposed bill.

2/National Industrial Conference Board, Inc., Research Report No. 42, op. cit., p. 45.

3/Ibid., p. 1.

4/Ibid., pp. 2-3.

perch; and forty perches in length and four in breadth an acre'..../The corn gallon and the corn bushel (Winchester) of 1495 were used in Great Britain until 1824, when a royal decree substituted/ the present imperial gallon and bushel....The fundamental units of length in the English system are the inch and foot..../which/ are of ancient origin, and are found with slight variations among practically all peoples....The English system decimalizes its units wherever expedient, but for most purposes uses the method of binary subdivision or repeated splitting into halves. The relationship between the inch and foot is duodecimal."1/

The report next discusses the origin and spread of the metric system, pointing out that in France various systems of weights and measures have been in use, "some of them dating back to the time of Charlemagne (768-814) ....The diversity of local systems in use resulted in considerable confusion, so that toward the end of the seventeenth century proposals, looking toward unification, came to the attention of the government..../One of the earliest of these was made by Gabriel Mouton in 1670. He/ proposed a comprehensive decimal system based on the length of the arc subtended by an angle of one minute of a great circle of the earth....The 'geometric foot' /he/ defined ....as corresponding to the length of a pendulum making 3959.2 vibrations in a half hour at Lyons..../At a later date/ M. Prieur Du Vernois proposed that one third of /the second's pendulum/ be designated /as/ the 'foot', and that this be divided into ten 'inches' of ten 'lines' each. Units of capacity were to be measured by cubes based upon the linear units. The unit of weight was to be a 'pound' corresponding to the weight of a cubic 'foot' of distilled water at some designated temperature....

"The French government in 1790 appointed a committee of the Academy of Science to undertake the making of a new system based upon some fundamental scientific measure....The committee....decided to use the one ten-millionth part of a quadrant of the meridian passing through Dunkirk and Barcelona as the standard unit of linear measure..../This was to be designated as the mètre./ A provisional mètre was derived by calculation,2/ and fixed /temporarily/..../The system of nomenclature, using/ Latin prefixes, was decided upon..../and the relations between the measures of length, weight, and capacity devised, so that/ the litre, which is the basic unit of capacity, is the volume of one-tenth mètre cubed. The gramme, which is the fundamental unit of mass, is the weight of a volume of pure water at maximum density, equal to one-hundredth of a mètre cubed. With respect to the multiplication and division of units the system is distinctly decimal..../using/ decimal notations and no other. The mètre is divided into tenths (décimètres), hundredths (centimètres) and thousandths(millimètres), while for more minute measures the millimètre is further divided into hundredths. The larger unit of linear measure is the kilomètre of 1,000 mètres. In a similar manner the litre, for capacity measures, is subdivided into décilitres and millilitres, and the larger units are the décalitre, the hectolitre, and the kilolitre. The larger units of weight are the kilogramme

1/Ibid., pp. 5-8.

2/Ibid., pp. 9-10.

Appendix C2. (continued)

of 1,000 grammes, the quintal of 100 kilogrammes, and the tonne of 1,000 kilogrammes1/....August 1, 1793, a decree was issued adopting the new system, and outlining the means for establishing it....In 1799 the provisional mètre was abolished, and the new mètre and kilogramme adopted by statute....These standards....are the ones in use today, although later researches have shown that a slight discrepancy exists between the mètre and one ten-millionth part of the meridional quadrant and between the kilogramme and the weight of a cubic décimètre of water at maximum density, to which the kilogramme was intended to be equivalent....Moreover the meridional great circle is not constant in length..../The new system was unpopular from the very beginning, and it became necessary in 1800 to issue the decree/ 'that the decimal system of weights and measures would definitely be put into execution for the entire Republic beginning September 23, 1801.' /Eleven years later Napoleon, realizing the folly of attempting to enforce legislation, which ran so counter to public opinion, issued a/ decree, establishing as optional a system of measurements based upon the metric system and using such divisions and multiples as would make the new units approximately those of the old system. To the units of this newest system the old terms were applied. /So much confusion and fraud resulted from the use of the two/ new systems and the natural reversion to the old system /that a decree was issued in 1837/ declaring all weights and measures other than the metric units forbidden after January 1, 1840..../In spite of this compulsory act/ difficulties in its enforcement have been encountered down to the present day."

The metric system has spread all over the world, so that to date it has been legalized in every well-known country except Australia and New Zealand, but optional use has not carried "with it the abolition or suppression of other systems of weights and measures in use, such suppression not usually being effected unless the metric system has been adopted as the sole legal standard of the country, and its use thus made compulsory."2/

Chapter III deals with the present national status of the English and the metric systems. The English predominates in twelve countries with a total population of 343,557,000, while in twenty-eight other countries with a total population of 823,690,000 neither the English nor the metric is in predominant use. The metric system predominates in thirty-seven countries with a population of 395,521,000.3/ In every country "where the metric system has superseded earlier local systems, it has done so mainly through the force of compulsory law. Even with such aid its general establishment has met with considerable difficulty, and in many metric countries is still far from complete."4/

A discussion of weights and measures in the United States follows. In the English colonies these were based almost entirely on the weights and measures of the mother country, and the standards were derived from those of the Exchequer of England. "The principal units were the yard, the

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1/Ibid., pp. 13-14.

2/Ibid., pp. 10-13.

3/Ibid., pp. 18-33.

4/Ibid., p. 34.

avoirdupois pound, the gallon, and the bushel," but divergencies became so common, that the Articles of Confederation (1777) gave Congress the power to fix the standard of weights and measures throughout the United States. The Federal Constitution later provided Congress with similar power. In 1790 the House of Representatives referred the matter of securing uniformity to a committee and to the Secretary of State, Thomas Jefferson, who after several months of study submitted two distinct plans. One was to "adapt a new system from the English, and base it upon a proposed second's pendulum standard. His other plan was a strictly decimal system, the purpose of which was 'to reduce every branch to the same decimal ratio already established for the coin, and thus bring the calculation of the principal affairs of life within the arithmetic of every man, who can multiply and divide plain numbers.' The fundamental foot....was derived by taking one-fifth of the length of the proposed standard rod (58.72 inches), and from this unit building up a series of shorter or longer ones for linear measure. The units of area, volume, capacity, and weight were to be based upon the linear unit..../Due to/....the agitation for a change in weights and measures then taking place in France and Great Britain....Congress did not adopt either of Jefferson's proposals, but awaited the outcome /in Europe/ ....France....had adopted the metric system /in 1793 and two years later in 1795/ a committee from the House of Representatives....made a study of the French plan in connection with Jefferson's decimal plan..../This committee/ made recommendations of a general nature involving scientific experimental work..../but these/ never received authorization from Congress....1/

"/In 1814/ the Coast and Geodetic Survey....imported from England an 82-inch brass bar scale made by a London manufacturer, named Troughton. Thirty-six inches taken on this scale were adopted as the standard yard for use by the United States Treasury and by other government departments. For its official and triangulation work, and for its precise leveling, magnetic work, and gravity investigations, however, the Coast and Geodetic Survey finally selected the meter, which has been used for such purposes ever since, although the results of triangulation and precise leveling are stated in both meters and feet." Five years later (1819) a committee of the House of Representatives submitted a report "advising the adoption of the first plan proposed by Jefferson, which was an adaptation of the English system, and recommending that standards for the yard, bushel, and pound conforming to those in most common use be established under the direction of a commission to be selected by the President. This system thus standardized, if satisfactory to Congress, was to be declared the standard for weights and measures in the United States...."

In the meantime another Secretary of State, John Quincy Adams "undertook a thorough analysis and study of the entire subject." At the end of four years (1821) his results were made public in a scholarly and impartial report, which is "a classic in American metrology."2/ Adams recommended

1/<u>Ibid</u>., pp. 36-37.

2/Hallock and Wade, <u>op. cit</u>., p. 116.

"that no present change in the weights and measures of the country be attempted,"1/ because "the benefits of the metric system had not yet evidenced themselves." Congress considered the recommendation made by the committee in 1819 together with the report by Adams, and finally made "a negative recommendation." The Adams report, however, influenced Congress to the extent that in 1828 it passed "an act establishing the Imperial standard Troy pound of England as the standard for the Mint of the United States..../while in 1830/ the Senate passed a resolution ordering the comparison of the local customhouse standards with those kept in the Treasury Department....Great lack of uniformity /was found, and as/ the standard measure of length procured by the Coast Survey in 1814 corresponded exactly to the unit of length established as the legal unit of Great Britain in 1758,"2/ the Treasury Department ordered in 1838 that complete and uniform sets of standards of weights and measures should be constructed in the office of the Coast Survey, and distributed to the states and territories. But "before copies of the standards could be constructed it was necessary for the Treasury Department to determine upon certain units and to adopt material standards representing them." Those finally adopted were the yard of 36 inches, measured on the Troughton 82-inch brass bar; the avoirdupois pound of 7000 grains; the gallon of 231 cubic inches; and the Winchester bushel of 2,150.42 cubic inches. "By 1856 the various states were supplied with sets of standards through the United States Coast Survey, and not long after their receipt the individual states enacted statutes establishing them as their standards of weight and measure. Thus was the English system unified and standardized for the entire country."

There was, however, continued interest in the metric system, and in 1854 "the American Geographical and Statistical Society presented a memorial to Congress urging the appointment of a scientific commission to consider a decimal system of weights and measures." Also in Latin America the metric system was adopted generally by the governments during the next ten years, so that in 1866 "an act was passed by Congress authorizing the use of the metric system in this country....In the same year acts were passed authorizing the Treasury Department to furnish the states with metric weights and measures, and the Post Office Department to use the metric system for foreign mailing and other purposes..../Five years later/ in 1871 the United States government accepted an invitation from the government of France to send delegates to Paris for the purpose of forming an international commission to construct new metric standards. Out of this convention grew the agreement to establish and support the International Bureau of Weights and Measures." International prototype standards of the standard meter and kilogram were distributed in 1889 to the nineteen participating nations, including the United States.

Congress passed an act in 1893, which established "a standard scale for the measurement of sheet and plate iron and steel, expressed in terms

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1/Adams, *op. cit.*, p. 135.

2/National Industrial Conference Board, Inc., Research Report No. 42, *op. cit.*, pp. 38-40.

Appendix C2. (continued)

of both the customary and metric measures,[1] /while that same year/, the Secretary of the Treasury approved an order from the Chief of the Bureau of Standards recognizing 'the international prototype meter and kilogram as the fundamental standards,' and directing that the customary units--the yard and the pound--be derived therefrom in accordance with the 1866 act. This order, however, had no legal force, since the power to fix the standard of weights and measures is vested in Congress alone..../In/ 1894 /an act/ defined and established units of electrical measure, which are the international electrical units, related to the metric system, definitely agreed upon at a congress held in Chicago....

/To date/ various bills have been introduced into Congress to establish the metric system as the sole legal standard of weights and measures. The general tendency of all these bills has been to make the system compulsory for official governmental use, and gradually to extend its compulsory use to the people at large....The latest of these, S.2267, introduced July 18, 1921....provides for the compulsory adoption of the metric system as the sole legal standard of weights and measures after ten years from the date of its passage."[2] Vigorous opposition has developed to this compulsory adoption of the metric system, as such a change is not believed necessary or desirable because:

1. In the United States today there is "no fundamental confusion with respect to weights and measures."

2. The United States "stands in the forefront of the great industrial and manufacturing nations, /and all/ its highly organized industry is based on the English units of weight and measure, while most of its vast technical literature is written in this system."

Therefore the question becomes "whether the advantages to be gained warrant the compulsory adoption of one unified system, the metric, in the place of another unified system, the English, which latter is, moreover, the established system, and enters so intimately into the present industrial organization of the nation."[3]

Part II of this report deals with the use of the English and metric systems in special fields, and "may be regarded as providing a cross-section of the situation presented in Part I."[4] In those countries where "the metric system has been made optional only,[5] its voluntary use has not extended beyond such fields as science and those branches of manufacturing making use of minute measurements, /while/ in those countries in which the

1/Ibid., pp. 40-41.

2/See Appendix B, pp. 209 - 211, for proposed bill.

3/Ibid., pp. 41-43.

4/Ibid., p. 45.

5/Ibid., p. 114.

metric system has been made compulsory for government uses, it has spread little beyond official departments. Even [among the countries] where [the law] makes the metric system compulsory for all uses, and [is enforced to any great extent] very few [of the] countries have been able to secure its adoption outside of legal transactions and in wholesale domestic trade, [whereas] in a number of [these] countries specific exemptions have been made, allowing the use of old units in certain fields, such as in the lumber trade, in land measurements, in engineering, in measuring drafts of ships, and so forth....In the field of domestic trade, it has sometimes happened that a compromise has been made between the old terminology and the metric units, thus satisfying the legal requirements while retaining old national or local names. Such basic industries as agriculture, mining, and manufacturing have been little affected by the operation of compulsory metric laws....

"The reasons for the continuance of old customs in spite of compulsory laws are, in general:

"1. In a number of special fields, the effort toward national unification on the basis of an entirely new system has appeared to offer little advantage, if any, over the old units.

"2. The difficulty and cost of introducing a new system in the field has appeared greater than any benefit that could be derived from complete unification on the basis of that system.

"3. Factors of international trade, built upon older units have encouraged the persistence of these units....

"With the exception of pure and laboratory science, wholesale trade, and certain other industries and fields in countries where the compulsory use of the metric system is generally effective, in practically none of the fields of industry and productive activity of major importance--such as agriculture, mining, transportation, retail and foreign trade, and the manufacturing industries--in the United States and in other leading countries has the metric system a widely enough established use or position to readily displace the English or other local systems. The facts....indicate further that a compulsory change to the metric system in the United States would doubtless involve many fundamental and serious changes in the industrial and business equipment and practices of the country....These considerations [should] be taken into full account in investigating the advisability of such a change."

The outstanding features of the situation regarding the use of weights and measures in various fields in the United States (1910) are as follows:1/

1. There are "71½ million people in the United States, 10 years of age and over, most of whom are affected by the use of weights and measures, as the buying and traveling public."

1/Ibid., pp. 118-119.

Appendix C2. (continued)

2. There are 38 million "productive workers 10 years of age and over."

3. In science and engineering there are 500,000 workers, while in foreign and wholesale trade there are 100,000 (estimated) workers, making a total of a little over half a million workers, or approximately 1% of the total number of productive workers in "the only fields interested to any extent in seeing the metric system adopted in the United States."

4. In agriculture, mining, transportation, and retail trade there are over 19½ million workers, or approximately 50% of the total number of productive workers.

5. In manufacturing and construction there are over 10½ million workers, or approximately 30% of the total number of productive workers.

6. In professional and clerical service there are over 7 million workers, or approximately 19% of the total number of productive workers.

7. Therefore 99% of the productive workers in the United States do not want the use of metric system made compulsory in the United States, while only 1% are at all interested in such a change.

8. The proportion in relation to the buying and traveling public is only about 1/2 of 1% which favor a change to the compulsory use of the metric system in the United States, while 99.5% do not favor such a change.

Part III presents the leading arguments for and against the substitution by compulsion of the metric for the English system of weights and measures in the United States. A summary of the metric contentions and the English answers in regard to the five main issues is as follows:[1]

I. Is the metric intrinsically superior to the English system?

"1. Are the fundamental units of the metric system intrinsically superior to those of the English?

"2. Is the manner of multiplication and division of units in the metric system superior?

"3. Are the units in common use in the metric system fewer, and are their names more easily learned and retained than those of the English system?

"4. Does the simplicity of structure, indicated in the discussion of the three preceding questions, make the metric system more comprehensible than the English?

"5. In practical use is the metric system more convenient, more adaptable, and more comprehensive than the English in filling the

1/Ibid., pp. 212-216.

Appendix C2. (continued)

needs that a system of weights and measures is called upon to fill?"[1]

"Metric Contentions"	"English Answers"
"The metric system is intrinsically superior to the English due to:	
1. "The scientific character of the fundamental units....meter, liter, and gram, and the simplicity of the relationship between them.	1. It is denied "that the fundamental units of the metric system are absolutely scientific in character....and that there is /much/ practical value in having measures of weight, length, and capacity related to one another. The practical and natural character of the fundamental units of the English system make..../it/ intrinsically superior to the metric.
2. "The simple decimal manner in which multiplication and division of units of the same measure proceeds, and which....	2. "The binary and duodecimal manner in which multiplication and division of English units proceeds is of superior value..../because/
a. "Makes the metric system easier to work with.... b. "Makes for simplicity in computations. c. "Avoids the present mixture of binary and decimal fractions in use in the English system.	a. "Common fractions are easier to visualize and therefore, to work with, than decimals, and although decimals do lend themselves to calculations, common fractions are superior for general practical use.... b. "The English system is adapted equally to the use of both binary and decimal fractions, by reason of which it is able to meet a need in human nature for the use of binary and duodecimal relationships, which need cannot be filled by the metric system with its strictly decimal structure.
3. "The smaller number of units in common use, and the greater ease with which the names are learned and retained.	3. "The common units of the English system are fewer in number, and their names, being of ancient origin and mostly monosyllabic, are more easily learned and retained than are those of the metric system.
4. "The greater comprehensibility of the system, as evidenced by the simplicity of structure	4. "/It is denied/ that simplicity of structure is synonymous with easy comprehensibility....The English system is

1/Ibid., pp. 123-140, 212, 214.

Appendix C2. (continued)

indicated under 1, 2, and 3 /above/....

more comprehensible than the metric, /because/ its units

a. "Fit everyday needs
b. "Are fewer in number
c. "Are of handy sizes
d. "Are brief in name
e. "Are easily memorized and associated with everyday experience....

5. "Its greater convenience, greater adaptability, and greater comprehensiveness in filling the needs that a system of weights and measures is called upon to fill."

5. "The English system is more convenient, more adaptable, and more comprehensive in filling the needs that a system of weights and measures is called upon to fill, because of:

a. "Its binary and duodecimal divisibility
b. "The practical relationship of its units
c. "Its adaptability to the requirements of progress as seen in the dropping of obsolete units, which had outlived their usefulness....
d. "Its use of both binary and decimal subdivisions."

II. Would a change in the United States to the metric system, because of its advantages in the following fields, or because of the extent of use it has already achieved in them here and in the rest of the world, be beneficial in the special fields of:

1. Educational work;
2. Scientific work;
3. Engineering;
4. Agriculture, mining, and transportation;
5. Manufacturing industries;
6. Domestic trade;
7. Foreign trade?[1]

"Metric Contentions"

1. "The metric system is of superior advantage and in extensive use in calculations, educational work, technical literature, and so forth.

"English Answers"

1. "The metric is neither of greater advantage nor in more extensive use than the English system in calculations, educational work, technical literature, and so forth.

1/Ibid., pp. 141-160, 212, 214-215.

Appendix C2. (continued)

2. "It is of superior value and in predominant use in scientific and related pursuits.

2. "While admitting certain advantages and use of the metric system in science and in fine instrument making, [it is maintained that] the so-called absolute, or 'centimeter-gram-second,' system rather than the metric....is the one employed in scientific work; and that the use of parts of the metric system in scientific work is not an indication of the advisability of adopting it generally, since the scientific field is small and its methods and products not fixed or standardized.

3. "It is applicable, and used very frequently in engineering activities.

3. "Electrical engineers use a 'mongrel system,' and not the metric....The English system is more applicable and more generally used, especially in the United States and Great Britain, in other engineering fields.

4. "The advantages and use of the metric system in scientific fields warrant a change to this system in agriculture, mining, and transportation activities as well, because of the intrinsic merits of the system, and because the increasingly close relation between the development of these fields and scientific research emphasizes the importance of using one system in all of them.

4. "The metric has no advantages over the English system in agriculture, mining, and transportation, while the English....is thoroughly established in daily use in all these fields, and has been found adequate in filling the needs of the people. Furthermore only confusion would result from such a change.

5. "The advantages and use of the metric system in manufacturing warrant a change in this field.

5. "The metric system offers no special advantages in manufacturing in general, while the whole manufacturing field in the United States has been built up in and around English units. The English system is especially applicable to most industrial processes....Many industries the world over have been developed in this system, and....it is used in many metric countries in the manufacture of special products.

6. "The metric system would be found advantageous in domestic trade.

6. "The metric is not better adapted to domestic trade than the English system, while the English....is thoroughly established, and in daily use in retail

trade....A change would require the changing of the habits of the entire buying public, which the experience of other countries has shown would be difficult....

7. "Because of its wide use in the foreign trade of other countries, its adoption here would foster the trade of the United States."

7. "A compulsory change to the metric system would not be advantageous to the foreign trade of the United States, since that trade is already established and flourishing in the English system, and since at least half that trade is with non-metric countries."

III. Would a change from the English to the metric system of weights and measures in the United States be practicable?

"1. Does the experience of other countries indicate that there would be serious general difficulties involved in a change in the United States through its relation to general popular customs and habits and to practices in the chief fields of activity, and how would various forms of compulsory law affect these difficulties?

"2. How and to what extent would such a change affect established mechanical standards?

"3. Would the cost of such a change in this country be prohibitive?"1/

"Metric Contentions"

1. "The experience of other countries in suppressing older units shows that there would be no serious general difficulties involved in a change to the metric system through its relation to general popular customs and habits and to practices in the chief fields of activity, and that the people would adopt the new units easily and without confusion after a short period of transition, especially if the compulsory law were gradually applied and extended.

2. "Such a change would necessitate little altering or discarding

"English Answers"

1. "The experience of other countries shows, [on the contrary], that [a] change [to the metric system] involves enormous disturbance to the everyday habits and customs of the whole buying and traveling population of a country, and creates untold confusion in business practices, and that the transition requires a long period. All of which difficulties would be intensified in the United States regardless of the character of the compulsory legislation, because the English system is thoroughly established here.

2. "The adoption of the metric system would necessitate the immediate discarding

1/Ibid., pp. 161-188, 213, 215-216.

Appendix C2. (continued)

of mechanical standards and equipment, but would involve, in the main, only the applying of metric measurements to the units of our present standards, which would be preserved without change so long as it might be desirable or advantageous to do so.

3. "The cost of such a change has been greatly over-estimated, and would involve only the translation and revision of literature and the replacing of present weights, measures, and scales.... The cost of such revision would be more than compensated for by savings resulting from the change."

of the established system of standards and the equipment embodying it, and the abandonment of interchangeable parts, because it would be impossible to apply equivalent metric designations to old standards, or to gradually replace old standards and equipment with new metric ones. [Therefore] a protracted period of waste and confusion would have to be reckoned with in any case.

3. "The cost of such a change would be tremendous, in fact prohibitive, involving not merely translation and revision of literature but enormous and costly changes in material and equipment, [as well as] slow and difficult reeducation of the people. To industry the material cost would average over $200 per worker, plus the additional expense due to inefficiency, waste, and the carrying of a double stock of repair-parts over a long period of years."

IV. "Is there a demand worthy of serious consideration for a change to the metric system in the United States?"1/

"Metric Contentions"

"There is a strong and growing demand for a compulsory change to the metric system in the United States. This is evidenced by the general extent of the demand as seen in many petitions to Congress signed by thousands....and by the character of the demand, representing as it does, many varied interests, such as: science, chemistry, invention, education, engineering, manufacturing, exporting, and so forth."

"English Answers"

"There is no demand worthy of serious consideration for a change to the metric system in the United States....What little demand there is comes mainly from scientists, teachers, and associations formed for the purpose of spreading metric propaganda, while decided opposition comes from manufacturers, engineers, and those involved in other large and practical fields, which are the ones that would suffer most through a change."

V. "Has the metric system, generally speaking, a better chance than the English of becoming the universal standard?"

1. Is the metric, by and large, used more generally the world over than the English system, and therefore stands a greater chance of becoming

1/Ibid., pp. 189-198, 213, 216.

Appendix C2. (concluded)

universal?

2. "Do the advantages and use of the metric system in special fields warrant its extension to all fields?"

3. Are its chances of adoption increasing annually in Great Britain and the United States, the two important countries remaining outside the metric fold?[1]

"Metric Contentions"	"English Answers"
1. The metric system "is used, by and large, more generally than the English," and so has a better chance "of becoming the universal system."	1. "The English system, not the metric, is used, by and large, more generally, and has, therefore, the better chance of becoming established as the universal system.
2. "The advantages and use of the metric system in certain fields warrant its extension to all fields.	2. "It is denied that the advantages and use of the metric system in certain fields warrant its extension to other fields....The advantages and use of the English system in the larger and more important fields justify the retention of this system in those fields and its use in all fields of activity.
3. "Sentiment in favor of a change to the metric system is growing in Great Britain and the United States."	3. "It is denied finally that the metric system is gaining strength in Great Britain and the United States. The fact of its insignificant adoption, after having been permissive for 55 years..../is/ conclusive evidence that the people in these countries do not want it. Furthermore....on the contrary, there is increasing indication that the English system, somewhat simplified and decimalized, as it can readily be to any desired extent, is rapidly coming to be fully recognized as the ideal system, destined, for this reason, ultimately to come into universal use."

1/Ibid., pp. 199-211, 213, 216.

Appendix C3. Summary of the Hearings before a Subcommittee of the Senate Committee on Manufactures (Sixty-seventh Congress, First and Second Sessions) in regard to the Ladd Metric Bill

The metric controversy in the United States, pro and con, is set forth in detail in these "Hearings," in regard to the Ladd Metric Bill. This pamphlet was printed in 1922 for the use of the Committee on Manufactures of the United States Senate. The bill, S.2267, Sixty-seventh Congress, First Session, proposed "to fix the metric system of weights and measures as the single standard of weights and measures for certain uses."[1]

The Subcommittee, Senator Charles L. McNary, chairman, heard first the proponents of the bill;[2] then the opponents;[3] and finally the rebuttal.[4] The proponents of this bill argued that:

1. The metric system has the following advantages:

   a. "The units of length, volume, weight, and so forth, are interrelated, so that calculations, involving the interrelation of such units, are greatly simplified.

   b. "Each unit is decimally multiplied and subdivided.

   c. "The same name denotes the same thing."[5]

2. It costs little or nothing to change over a manufacturing establishment from the English to the metric system, as is proved by the testimony of the De Laval Separator Company of Poughkeepsie, New York, and Carl E. Schmidt and Company, Detroit, Michigan. "Destruction or discarding of the present system of mechanical standards or the equipment embodying it" is not necessary. For the most part it would be sufficient merely to express the present standards in metric terms, while "any alteration or destruction, which became advisable, could be effected gradually and without confusion, as the equipment wore out and had to be replaced."[6]

3. Much confusion, time, and money would be saved; about two years for children in school or in one generation a million years; and much in various concerns particularly in the wholesale drug business and in laboratories.[7]

1/See Appendix B, pp. 209-211, for proposed bill.

2/United States Hearings, 1922, op. cit., pp. 3-169.

3/Ibid., pp. 171-320.

4/Ibid., pp. 321-439.

5/Ibid., pp. 6, 66-67, 266.

6/Ibid., pp. 4-8, 23-26, 64-65, 81, 156-159, 161-162, 298, 421.

7/Ibid., pp. 9-10, 19-22, 28, 37, 39, 53-54, 77, 118-120, 123, 159, 325-328.

Appendix C3. (continued)

4. The metric system is simple and convenient for practical use, because fractions are eliminated.1/

5. The farmer's unit, the bushel, is in reality a multiplicity of units; the English "dry measures differ from the American dry measures by about 3%," while the English "liquid measures differ by about 20%"; and there are two kinds of tons.2/

6. The time to be allowed for the transition period from the English system to the metric is too long.3/

7. Our export trade would be benefited.4/

8. The permissive law is worthless. Compulsory legislation is necessary to effect such a change. It could be adjusted so that the change would "take place in easy stages, and so cause little confusion or inconvenience" by:

   a. Requiring the use of the metric system "in Government departments and in the schools." Thus "manufacturers and the public generally could gradually familiarize themselves with it and adapt themselves to it."

   b. Extending the use of the metric system "by legislation to domestic trade. In this way the manufacturing field would be given ample time and inducement to adopt the system voluntarily."5/

9. The Pharmacopoeia now uses the metric system.6/

10. Our customary weights and measures encourage cheating and profiteering.7/

11. The obligatory metric law in the Philippine Islands, involving about eight million people, has worked satisfactorily.8/

12. Of the Navy bureaus, Medicine and Surgery, Supplies and Accounts now use the metric system.9/

13. The army Medical Department and the Signal Corps now use the metric system.10/

1/Ibid., pp. 31, 67-69, 138, 159, 295.

2/Ibid., pp. 44, 45.

3/Ibid., pp. 61, 81, 155, 299.

4/Ibid., pp. 10, 14, 32-42, 69-70, 78, 126-131, 149-151, 165, 168, 328.

5/Ibid., pp. 72-74, 300.

6/Ibid., p. 79.

7/Ibid., pp. 80-81, 122, 132-133, 138, 169, 409.

8/Ibid., pp. 83-84.

9/Ibid., p. 87.

10/Ibid., p. 95.

Appendix C3. (continued)

14. The metric system is useful to chemists, and therefore "is good for the people at large."[1]

15. More than 103,000 people have petitioned requesting Congress to pass this bill.[2]

16. The names of our weights and measures need not be changed, only the values.[3]

17. Preparedness to defend again "world civilization" requires metric standardization.[4]

The opponents of the bill argued that:

1. Our customary weights and measures are "uniform throughout the country, [and on this English system] our industrial achievements have been built. It has adapted itself to changing conditions and serves our purpose well....[5]

2. "Experience has shown that it is impractical to change such deep-rooted habits by law. Such results can only be achieved gradually [by the orderly processes of education and evolution in American industry and trade,] and not even then unless the change can prove its merits....The final test must be the survival of the fittest under the law of natural selection....[6]

3. "The law of 1866 makes the use of the metric system permissible in the United States; those who want to use it can do so. In spite of this permission, it has made little, if any, progress in the industrial and daily life of this country....[7]

4. "Trying to maintain domestic manufacture on the English system and domestic trade on the metric, as provided in Section 3, [would impose a dual system, which would lead only to confusion, thus] nullifying the claim that the use of the metric system will simplify the multiplicity of daily transactions....[8]

5. "The United States law of 1866 defines the meter in terms of the inch, the equivalent being 39.37 inches. This inch is the inch of England, which is thus made the fundamental standard of the United States by statute law, as it has been under common law since the

1/Ibid., pp. 53, 124, 138, 144.

2/Ibid., p. 41.

3/Ibid., p. 133.

4/Ibid., pp. 146-148, 402.

5/Ibid., pp. 172, 287.

6/Ibid., pp. 95, 172, 268, 277-279, 287, 300.

7/Ibid., pp. 172, 234, 249, 267, 290, 292.

8/Ibid., pp. 173, 177, 189, 230, 279-280, 300.

Appendix C3. (continued)

first English settlement in 1607. [The enactment of Section 2] would establish a difference in the fundamental standards as used in the United States and in Great Britain, and would complicate the work of standardization for the English-speaking peoples."1/

6. This bill is only a makeshift and "a preliminary step to the compulsory introduction of the metric system into every activity of the United States," which would cost a tremendous amount of money. A summary of questionnaires sent out by the American Institute of Weights and Measures in regard to the cost to manufacturing concerns of changing to the metric system is as follows:

Aggregate cost to 31 concerns	$21,464,688.00
Average cost per concern	$715,489.60
Workers employed by 31 concerns	94,392
Average cost per worker	$227.40 2/

7. "The bill exempts export trade from its provisions, [therefore it will not] help us obtain foreign trade.... The use of the metric system has absolutely nothing to do with export trade and would not be a factor in promoting it. The foreigner will buy the cheapest goods consistent with quality, the best machines, irrespective of the system they are manufactured or built to, provided many other conditions allow him to do so. Among these are, price, exchange and credit conditions, tariffs, freights, deliveries, and so forth....3/

8. "This bill would not decrease, but materially increase, the time and effort required in the education of the school child, [because it imposes] a dual system, the simultaneous use of two systems unrelated to each other, [which would make it necessary to become] familiar with the relation existing between units of the systems" (conversion).4/

9. A canvass, by mail, of manufacturing chemical concerns, made in 1917 by the American Institute of Weights and Measures gave the following results:

 21 - replies received.
 19 - metric system not used at all.
 1 - metric system used slightly.
 1 - metric system used extensively.5/

10. The metric equivalent scheme is not used by any metric country, National Industrial Conference Board investigations during the past

1/Ibid., pp. 173-176, 318-320.

2/Ibid., pp. 104-105, 172-182, 184-186, 187, 231-232, 240-241, 243, 245, 251, 253, 255-257, 265, 298.

3/Ibid., pp. 163, 182, 227, 240, 296.

4/Ibid., pp. 182-184, 230, 234, 272, 274.

5/Ibid., pp. 184, 239-240.

twenty years show. "Standard sizes based on old units are found in use in all metric countries, and these are always measured in the old units--never in metric....[1]

11. "Our system, having been developed to meet the requirements of daily life, would long have ceased to exist [if the charge, that it] lent itself most readily to fraud, [could be maintained.] Existing rules and ordinances fully safeguard the individual. [A dual system would offer greater opportunities for fraud because of] the ensuing confusion."[2]

12. "Off-hand decisions," such as the action taken by the City Council of Chicago in passing a resolution for compulsory metric legislation, are of little value. "This resolution was referred to the committee on judiciary; no hearings were advertised or held; no one interested in such action for or against it, except the promoters of the resolution, was aware of what was contemplated." In New York City, however, "publicity was given to the question, with the result that both sides could express their views to the committee. The resolution there was tabled without action, on the ground that the board of aldermen did not feel competent to pass on this matter."[3]

13. Not more than 1/10 of 1% of the whole population constitutes the demand for metric legislation. This very small minority consists mainly of scientists, teachers, "pharmacists, some engineers, laboratory chemists, physicians, and a number of enthusiasts who, carried away with the idea of universal uniformity, have taken metric arguments for granted [and have not studied the practical problems involved. This prometric group is] strongly supported by the United States Bureau of Standards....The average American has given no thought whatever to the compulsory adoption of the metric system or to the practical and economic problems, which would surround its introduction."[4]

14. The fact that other countries have adopted the metric system is not an argument in favor of its compulsory adoption in the United States because:

    a. In the United States there is "no fundamental confusion with respect to weights and measures."

    b. The United States is a great industrial and manufacturing nation and "its highly organized industry," manufacturing, and vast technical literature are based on the English system of weights and measures.[5]

1/Ibid., pp. 186, 232-234, 298.

2/Ibid., pp. 187, 267.

3/Ibid., p. 189.

4/Ibid., pp. 190, 266, 287, 297-298, 300.

5/Ibid., p. 190.

Appendix C3. (continued)

15. A large number of antimetric resolutions have been passed by various public bodies and national associations.1/

16. The metric system "as a whole has broken down everywhere....In its entirety it includes the division of the circle into 400 degrees and the decimal division of the calendar, the clock dial, and the mariner's compass, and, for the purposes of the navigator these are essential portions of the system....but they are used nowhere." South American countries are nominally metric, but actually have "a double and in many cases a triple system of weights and measures." In Germany, Belgium, and France there are many exceptions to the metric law.2/

17. "The metric system is devoid of the English system's handiness and convenience; its units are either too large or too small for the everyday requirements of industry"; 10 has only two factors, 2 and 5; whereas 12 has 6, 4, 3, and 2. "The use of decimals is adapted to easy computation," but it is not "of equal advantage in the actual process of physically measuring or weighing things either in manufacture or in trade....From the English system many subdivisions have been dropped, having outlived their usefulness, thus proving this system's adaptability to the requirements of progress." It makes use of binary as well as decimal division.3/

18. "The weight-bushel situation....will not be changed in the slightest by the adoption of the metric system, /because/ these weight-bushels are due to the fact that different agricultural products are of different densities. Wheat, corn, and rye do not weigh the same per hectoliter any more than they do per bushel....The remedy for this condition, if it needs a remedy, is to sell all these products by the same unit of weight, such as the cental or hundredweight."4/

19. An investigation (1918) of weights and measures in Latin America by the American Institue of Weights and Measures shows that old names are not used for new units.5/

20. "The 10-year period /of transition/ is far too short for any turnover from the present system /of weights and measures/....It would....require 50 to 75 years.6/

21. "Metric legislation has followed a fairly uniform course everywhere.... /The steps are:/

1/Ibid., pp. 191-216.

2/Ibid., pp. 218-219, 227, 229-230, 234, 237-238, 258-259, 261-263, 279-280, 287, 299.

3/Ibid., pp. 91, 95, 97, 219-225, 266, 269, 281-284, 296, 302.

4/Ibid., p. 235.

5/Ibid., pp. 236-237.

6/Ibid., pp. 241-242, 248, 299.

a. "Simple legalizing of the metric units /U. S. law of 1866/....

b. "Passage of a law making the use of the /metric/ system compulsory for governmental purposes only /Bill heard by the House Committee on Coinage, Weights and Measures in the Fifty-eighth and Fifty-ninth Congresses--killed in committee/....

c. "Compulsion for all purposes, with certain exceptions perhaps.

"The present bill is an attempt at an intermediate step, making the system compulsory in domestic trade, but not in manufacture."1/

22. There is no practical value in the interrelation of units "in the ordinary transactions of trade, whatever its value may be in scientific calculations or the experiments of the laboratory....2/

23. "Many words in the English language have a number of meanings..../but these/ several meanings to the same word cause no confusion to an American any more than they do in his system of weights and measures....Furthermore, sales, by weight are rapidly supplanting the dry measure in the markets.3/

24. "The scientist....finds /the metric system/ valuable in his work, /but it is not/ equally adaptable to the ordinary transactions of business, /because/ there is no fundamental or superficial relation between the work of the astronomer and the farmer; the physicist and the grocer; the laboratory chemist and the dealer in real estate. The intricate and profound calculations of the scientist are so essentially different from the comparatively simple problems of the farmer, grocer, real estate dealer, and so forth, that it is not surprising that the scientist requires a system peculiarly adapted to his work.4/

25. "The metric system is a propagandist system....The World Metric Standardization Council..../the World Trade Club, and the Association for World Commerce are examples of such organizations./ The English system, /however/, has maintained its preeminence through the natural avenues of trade and commerce on its inherent merits. International trade carries its own tools, and the dominant factors in that trade will inevitably impose their standards in the commercial markets of the world....This present time would seem to be a peculiarly inopportune time to consider the scrapping of the system of weights and measures upon which our industrial and commercial supremacy has been built.5/

1/Ibid., pp. 265, 274-276.

2/Ibid., pp. 91, 266.

3/Ibid., p. 267.

4/Ibid., p. 267.

5/Ibid., pp. 267-268, 269-270, 287, 300-301, 307-308.

Appendix C3. (continued)

26. "The overwhelming concensus....of the Navy Department..../is that/, in view of the /present/ economic situation..../and/ the great cost /involved, it does not recommend the change to the metric system/ unless and until the other English-speaking nations of the world will also adopt it.[1]

27. "The War Department as a whole is opposed" to the change to the compulsory use of the metric system, because of the cost involved in regard to maps and manufacturing.[2]

28. The English system predominates, as will be seen from the following summaries:[3]

	Population	Square miles	Countries[7]
Metric system predominant	358,331,000	7,531,099	37
English system fundamental or predominant	674,857,000[4]	21,215,740[5]	12
Local systems predominant	514,580,000	9,930,507	28
	1,547,768,000	38,677,346[6]	

	Meter group[8]	Inch group[9]
Wealth	$310 billion	$490 billion
Income	$ 24 billion	$ 70 billion

1/Ibid., pp. 86-94.

2/Ibid., pp. 94-110.

3/Ibid., p. 286.

4/179 million people use exclusively the English system (United Kingdom, British Dominions, and the United States).
164 million people in Russia use their own system based on the English system.
331 million people in India, Egypt, Cuba, and Panama use their own systems, but the English system predominates.

5/English-speaking - 11 million square miles
Russia - 8 million square miles
India, Egypt, Cuba, and Panama - 2 million square miles

6/Excluding the Polar Regions, Central Africa, and the Sahara Desert.

7/Ibid., pp. 67-68, 296.

8/Continental Europe.

9/United Kingdom, Australasia, Canada, and the United States.

Appendix C3. (continued)

29. Section 6 of this bill delegates "to the Department of Commerce the whole machinery for the enforcement of this act. Thus there would be created autocratic control by a Government bureau whereby it would have power to impose such rules and regulations for the enforcement of this act as it might see fit."1/

30. This bill provides no penalties "for nonobservance....It is not probable that Congress would pass a law and be indifferent to its enforcement, nor could it delegate to the Department of Commerce, entrusted with its execution, the task of fixing such penalties. Unless..../Section 10/ is enlarged....additional laws would have to be enacted by Congress" to provide for penalties.2/

31. "Congress, in the regulation of the weights and measures of the United States....should be governed by three general principles:

"I. To restrict the use of non-English weights and measures, whether of the metric or of other systems, keeping the United States standards, so far as possible, on an exclusively English basis.

"II. To take no important step affecting the English units of weights and measures, or their use, without consultation and agreement with all other sections of the English-speaking world.

"III. To shape legislation affecting weights and measures so as to harmonize Government control and the natural process of evolution by which the English system has been developed. These two influences, working together, bringing the English weights and measures nearer the ideal of perfect adaptability to the work of the world and the greatest attainable uniformity of usage.

/To carry out these general principles the following definite measures are necessary:/

"a. The misuse of the authority and resources of the Government for carrying on metric propaganda should be stopped at once, and the officials of the executive departments should be made to understand that their duty consists in obeying and administering the law, and not in evading it or carrying on propaganda for changing it.

"b. Close attention and careful scrutiny of every measure affecting weights and measures should take the place of the indifference and neglect that have become habitual.

"c. The Government should print at once John Quincy Adams' report on the metric system, adding to it a carefully prepared index

1/Ibid., p. 172.

2/Ibid., p. 173.

Appendix C3. (continued)

to facilitate reference....Congress should give no consideration to any law affecting our weights and measures until this is done.

"d. The former practice of comparing the material standards of the United States with the standards of Great Britain should be resumed, in order that the accuracy and permanency of the weights and measures of the English-speaking world may be assured by direct comparison of the standards of every section with the prototype standards at London.

"e. At the earliest practicable date representatives of the Governments of Great Britain, the British Dominions, and the United States should meet for the purpose of conferring on [steps] to be taken for the protection and uniform development of their common weights and measures."1/

32. If a standard decimal system of weights and measures is needed in the United States a bill, S.2856, proposing "to decimalize the foot and to derive the other weights and measures from the foot" should be considered in preference to the metric system.2/

The arguments of the rebuttal were:

1. Through propaganda the states should be urged "to adopt uniform education for the metric system, so that it would be taught uniformly in our public schools."3/

2. 102,842 petitions from national associations, corporations, and individuals have been classified with the result that nearly 99% favor a change to the metric basis.4/

3. Only one attempt, and this an unfair one, has been made by the opposition to estimate the cost of change.

4. Messrs. Stutz, Halsey, and Dale, who have presented much unverified material in opposition to the metric system have been employed from time to time by "Mr. Henry D. Sharpe, treasurer of a company that has a peculiar interest in opposing" this bill. Furthermore Mr. Sharpe has organized the opposition and contributed $1,000 to it.5/

1/Ibid., pp. 293-294.

2/Ibid., p. 301-318.

3/Ibid., pp. 323-325.

4/Ibid., pp. 300, 331, 379-380.

5/Ibid., p. 332.

5. Mr. Samuel Russell's testimony should "not be taken seriously," since he "is the author of a decimal bill, which attempts to create a practically new system of weights and measures."[1]

6. Mr. S. S. Dale is not an engineer, and yet he takes "issue with the leading authorities. [His] testimony is remarkable in its misuse and misrepresentation in regard to what the metric system is and how it should be used.[2]

7. "The metric system is winning its way entirely on its merits, just as it should, because it is easy to learn, to work with, and [it is] best suited for practical purposes."[3]

8. The present is a good time to make the change, because the "wheels of progress are slowed down" and the men who were in the Army during the war, have become acquainted with the system.[4]

9. Propaganda to prevent metric legislation in the United States was organized in Germany and has been constantly at work since 1871.[5]

1/ *Ibid.*, pp. 332, 374.

2/ *Ibid.*, p. 333.

3/ *Ibid.*, p. 336.

4/ *Ibid.*, pp. 337, 430.

5/ *Ibid.*, pp. 376-378.

APPENDIX D

PENALTIES FOR INFRACTION OF THE COMPULSORY METRIC LAWS IN SOUTH AMERICA

Appendix D1. Penalties in Brazil

Translated from Diário Oficial, Estados Unidos Do Brazil, Secção 1, N. 183, Quarta-feira, 10 de Agosto de 1938.

"Chapter V"

"Art. 2. The use or mention of units different than the legal system [metric] is prohibited in transactions as well as in documents of any nature whatsoever.

"1. The use of units different than the legal system shall be permitted:

"a. In all documents drawn up before the time mentioned in Art. 32 [1940];

"b. In all documents relative to businesses or persons who are in or have originated in a country where any system of units different than that referred to in Art. 1 [metric] is legal or considered lawful.

"2. The documents provided for in part (b) of the preceding paragraph must include, nevertheless, in the text or in an attached statement, the values of the weights and measures, mentioned in the other units, converted into the units of the legal Brazilian system.

"Art. 23. Any and every document, contract, or transaction shall be null and void which has violated Art. 2 or its paragraphs [see above].

"Art. 24. In cases of violation of the provision contained in the present decree, its regulation, or its respective instructions the offenders shall be punished by competent authorities with the penalties provided by the regulation, and these shall be one or both:

"a. A fine of not more than 1000\$000 [milréis];[1]

[1] \$250 if the milréis is translated as 25 cents, its actual value in Brazil; or \$51.50 if the milréis is translated as 5.15 cents, its value at the present rate of exchange (1941).

"b. Confiscation, or destruction of measures or measuring instruments.

"Art. 25. The regulation shall fix suitable penalties for abuses, offences, and violations committed by officials of the prosecuting body, which penalties may be applied to said officials without taking into consideration their civil liability:

"a. Warning;

"b. Fine not exceeding 1000$000 [milréis];

"c. Suspension from duty;

"d. Dismissal.

"Art. 26. In cases duly proved of technical deficiency, abuse, fraud, or disregard of the present decree, of its regulation, or of its respective instructions on the part of any body or individual delegated by a higher power to exercise metrological authority, the said authority may be suspended or annulled, totally or in part by the same body which gave the authority.

"Art. 27. From any penalty imposed or confirmed by the body appointed to execute the present decree there shall be redress in the form which the regulation establishes."

Diário Oficial,
Secção 1, N. 139.
Sábado, 17 de Junho de 1939.

"Chapter XII"

"Penalties"[1]

"Art. 86. All documents or transactions shall be null and void which have violated Art. 3 and its paragraphs 2, 3, 4, and 5 together with the regulations of Sec. 1 [only the metric system legal].

"Art. 87. A fine of 100$000 [milréis] shall be imposed in the following cases:

"a. Violation of any of the provisions of Art. 20, 33, and 40 [see pages 269, 270, 273].

"b. The use, as indicated in the concluding part of Art. 33, [see page 270] of measures or measuring instruments prohibited according to Art. 93 [see page 267].

[1]Note that the fines are smaller, but that there are more of them.

"Art. 88. There shall be imposed a fine of 200$000 to 500$000 [milréis] upon anyone who opposes the inspection and checking of the metrological body.

"Art. 89. There shall be imposed a fine of 200$000 to 500$000 [milréis] for measures fraudulently defective according to the provisions of Art. 37 and its paragraphs [see page 271].

"Art. 90. A fine of 300$000 to 500$000 [milréis] shall be imposed in the following cases:

"a. Adulteration or falsification, with intent to defraud, of any measure or instrument of measuring, as well as the numerical markings dealt with in Art. 38 and 39 [see pages 272 and 273].

"b. Adulteration or falsification of any receipts, certificates, visas, marks, or stamps with which this regulation deals, as well as of any other documents issued by virtue of Decrees 592 of August 4th, and 886 of November 24, 1938, of this regulation or instructions and other acts which complete them.

"Art. 91. There shall be imposed a fine of 100$000 to 500$000 [milréis] according to the seriousness of the case at the discretion of a competent metrological body upon anyone who violates in any way Decrees Number 592 of the 4th of August, and 886 of the 24th of November, 1938, of the present regulation, or of the instructions or any acts completing the same, which have not been expressly provided for in this chapter.

"Art. 92. The fines to which the preceding articles refer shall be doubled in the case of a recurrence of the offence.

"Art. 93. The use according to Art. 33 [see page 270] of any measures or instruments of measuring, which in the examinations or in the verifications do not satisfy all the general and special conditions set forth respectively in Art. 34 and 14 [see pages 270 and 271], shall be prohibited.

"Par. One. The prohibition shall be suspended only when a measure or instrument of measuring, duly regulated or put in order, is submitted to a new examination and verification, and satisfies all the conditions to which this article refers.

"Art. 94. Any instrument of measuring or any measure which has been adulterated or falsified with intent to defraud, shall be confiscated and destroyed, without taking into consideration any of the fines or other penalties which have been paid.

"Art. 95. Any official of the metrological body who does not do his duty, within his jurisdiction of authority, showing negligence or

committing any abuse of authority, fraud, or any other fault, without taking into consideration any other penalties which he may have paid, shall receive that of being warned, suspended, or dismissed, according to the seriousness of the case and according to the discretion of competent authorities.

"Art. 96. The exercise of any of the activities with which Art. 31 deals shall be forbidden to anyone who has practiced any of the violations provided for in Art. 90 /see page 267/ or has been guilty of abuse or fraud according to the provisions of Art. 95 /see above/.

"Art. 97. In cases, duly proved, of technical deficiency, abuse, fraud, or disregard of Decrees Number 592 of the 4th of August, and Number 886 of the 24th of November, 1938, of the present regulation or of the instructions and other acts, which complete the same, on the part of any body or individual to whom has been delegated the exercise of metrological jurisdiction according to Art. 53, 54, 55, /see pages 273 and 274/ and 56, there shall be imposed by the body delegating such powers the following punishments:

"a. Suspension, total or partial, of the delegation of powers for a period of from one to three months if, in the judgment of the punishing body, the fault is not so grave;

"b. Annulment, total or partial, of the delegated powers, if the offence is found to be serious, in the judgment of the same body.

"Sec.1. The punishment of suspension or annulment, entire or partial, of the delegated authority in exercising jurisdiction, shall be imposed by the chief of the competent metrological body, who shall provide for assuring the entire maintenance of the services undertaken by the punished authority.

"Sec. 2. Moreover, it is authorized that in a case of a manufacturer of measures or instruments of measuring or of a public utility enterprise there shall be imposed by a competent metrological body, and according to its criterion, a fine of 100$000 to 500$000 /milréis/ in accordance with the seriousness of the case, and it shall be doubled if the offence is committed again.

"Art. 98. The proceedings in regard to violations shall be based upon an accusation drawn up by officials in the metrological service or upon written complaint by individuals.

"Sec. 1. Duly summoned, the accused shall have a period of 30 days in which to present his defence, which must be accompanied by documents.

"Sec. 2. At the end of that time either a defense having been prepared or a declaration of default having been made, the proceedings, after all necessary acts, shall be judged by the presiding officer of the metrological body within whose jurisdiction the violation has occurred.

"Sec. 3. From this decision appeal may be made within a period of 20 days; voluntarily, if the decision is against the accused, or ex-officio if it is in his favor.

"Sec. 4. The appeal shall be presented to the director of the National Institute of Technology, and if it is a voluntary appeal, it shall only be considered upon prior deposit of the fine or a bond for a like amount.

"Sec. 5. At the request of the Metrological Commission and of the State body involved, in accordance with his authority, the director of the National Institute of Technology may hand down a decision which will conclude the case.

"Art. 99. The penalties imposed by virtue of this regulation shall not interfere with the application of other penalties, established by penal laws in force, and applicable to the same case."

"Chapter IV"

"Initial Examinations and Periodic Verification"

"Art. 20. Only measures and instruments of measuring, which have been approved in the initial examination, or which have been exempted in accordance with Art. 23 [see below] may be offered for sale or used in any business.

Par. One. The ruling in this article refers only to selling or doing business within the country.

"Art. 23. The following shall be exempt from the initial examination required by the preceding article:

"a. Measures and instruments of measuring already stamped in public departments, or in foreign scientific or technical establishments, judged fit by the Metrology Commission, and having certificates considered valid by the National Institute of Technology, or by a State body to which has been delegated the exercise of metrological jurisdiction.

"b. Fixed categories of measures or instruments of measuring for which for a good reason, such an examination shall be judged unnecessary, according to the criterion of the National Institute of Technology."

"Chapter V"

"Measures and the Tolerances Allowed"

"Art. 14. For the approval of the various types of measures and instruments of measuring, the director of the National Institute of Technology shall issue rules defining them, which shall be published in the Diário Oficial, and shall include at least:

"a. A description of the characteristics, indispensable and sufficient, which any measure or instrument of measuring should possess in order to belong to the approved type;

"b. The kind or kinds of measures the use of which will be permitted;

"c. The respective limits of use whenever there are any;

"d. The possible special conditions with which it ought to comply in the initial examination and periodic verifications, as well as in the supplementary verifications and examinations to which Art. 67 refers;

"e. Regulations in regard to the method to be followed in making the examinations and verifications referred to in the section above;

"f. A ruling as to the maximum interval of time to be permitted between the initial examination and the first periodic verification and between the two following periodic verifications;

"g. The regulations in regard to the procedure of affixing the legal stamp of approval in the initial examination and in the periodic verifications;

"h. The further requirements judged necessary in regard to the method of installing, maintaining, and using the measures or the instruments of measuring belonging to the type considered.

"Art. 33. For all measuring to which any document refers or upon which depend the value or values of any transaction or contract, there shall be used only the measures or instruments of measuring which:

"a. Belong to the type approved by the National Institute of Technology;

"b. Are of the sort permitted as a suitable kind of measure;

"c. Have been approved in the initial examination or have been

exempted according to the terms of Art. 23 /see page 269/;

"d. Have been verified periodically, the intervals not having exceeded those which the National Institute of Technology has fixed as reasonable for the type and the region, or have been exempted according to the provisions of Art. 26 /which is the same as Art. 23 on page 269/.

"Art. 34. The Ministry of Labor, Industry, and Trade shall issue instructions drawn up by the National Institute of Technology, providing:

"a. The manner in which the measures shall be executed for the purposes mentioned in the preceding article;

"b. The tolerances to be allowed for the errors of the defective measures;

"c. The general conditions with which the measures or instruments of measuring used must comply;

"d. The general provisions in regard to the method to be followed in making the initial examinations and the periodic verifications, as well as the supplementary examinations and verifications.

"Par. One. Among the general conditions to which part (c) of the above article refers are, as the maximum limits, the tolerances for the errors of the aforementioned measures or instruments of measuring.

"Art. 35. Different degrees of tolerance shall be authorized, according to the nature of the contract and the object of the measuring.

"Par. One. The tolerances for each kind of measure are hereby authorized to be different, the degree of expansion conforming to the metrological instruments in the respective region.

"Art. 36. The fixing of the tolerances to which the preceding article refers, shall be done by means of limiting as much as possible systematic and accidental errors, without causing difficulty in regard to the measures or without exaggerating unduly the end to be attained.

"Art. 37. The following kinds of tolerances shall be allowed:

"1. 'Systematic tolerance' is that which makes allowance for frequently recurring errors arising from defects in the measure, or measuring instrument, or from other causes;

Appendix D1. (continued)

"2. 'Tolerance of dispersion' is that which allows for the dispersion of individual values of the same size, obtained in consecutive measurings, in relation to the respective average value;

"3. 'Individual tolerance' is that which refers to the result of any isolated measuring which shall be greater than the tolerance of dispersion in a proportion established in accordance with the law of probability.

"Sec. 1. The tolerances of the first and second kind shall be used for the following purposes:

"a. To determine the general and special conditions which, according to the provisions of Art. 34 and 14 /see pages 270 and 271/, the measures or measuring instruments ought to comply with, in regard to an initial examination, periodic verification, and the supplementary examinations and verifications to which Art. 67 refers.

"b. To inspect and check according to the provisions of Art. 33 /see page 270/ and 41 the numerical markings for merchandise on sale.

"Sec. 2. The tolerances of the third kind shall be used in inspecting and checking the measures provided for in the regulations of Art. 33 /see page 270/, and the numerical markings for merchandise on sale, as well as in the special cases provided for in the provisions of part (a) of the preceding paragraph.

"Sec. 3. In addition to other cases of fraud, immediately and independently of any other proof, any numerical marking, the error of which is greater than the tolerance of the third kind, as well as all measuring with a similar error, shall be considered fraudulent whenever it has been done with measures and instruments of measuring not complying satisfactorily with the provisions of Art. 14 and 34 /see pages 270 and 271/.

"Art. 38. For determining categories of merchandise, if it is deemed convenient, the Ministry of Labor, Industry, and Commerce, at the instigation of the National Institute of Technology, shall specify the characteristics of the measure which is basic for the respective transactions, as well as the minimum of necessary marking which such merchandise should bear or which must accompany it, when on sale.

"Par. One. These markings should be expressed in legal units and should refer to the characteristics upon which depends the marketable value of the aforementioned merchandise, which is not ordinarily measured in the presence of the purchaser.

"Art. 39. All open or sealed packages containing merchandise shall bear, at least, labels indicating the quantity which each contains and shall guarantee, within reasonable limits, that this quantity shall remain the same.

"Art. 40. Only for imported goods or those which are to be exported and in other cases fixed by the National Institute of Technology shall there be allowed markings in units different from those which are lawful [metric].

"Art. 41. The markings to which Art. 38, 39, and 40 [see above] refer are considered the result of measuring, and to them there applies the provisions of Art. 33, 34, 35, 36, and 37 [see pages 270 and 271].

"Chapter VIII"

"Concerning Delegating the Exercise of the

Jurisdiction of Authority"

"Art. 20. Any public utility enterprise which operates within the national territory which requests it of a competent authority, and which agrees to acquire and to use monthly stamps for metrological purposes of a total value equal to the minimum fixed by the regulation, and possesses satisfactory apparatus, may be delegated with the duty of the initial examining and the periodic verification of measures or instruments of measuring according to the fixed categories, used in these services, and of issuing the respective certificates.

"Sec. 1. The powers mentioned in this article shall be exercised under the permanent control of the body charged with the duty of the technical inspection of the enterprise.

"Sec. 2. The certificates to which this article refers are legally valid only for the purposes of Art. 4 [see Art. 23, page 269] and 5 and must for that reason be countersigned by the body mentioned in the preceding paragraph.

"Art. 53. The exercise of the jurisdiction of the metrological authority, to which Art. 17 of Decree Number 592 of the 4th of August, 1938, refers, shall be delegated, in that territory, to any State metrological body which solicits it, at the rate of one, as a maximum, for a state, whenever that body satisfies the conditions of Art. 59 of the present regulation.

"Par. One. The delegating of powers to which this article refers may exclude the exercising of such delegated powers insofar as they concern Federal departments or businesses having Federal concessions.

Appendix D1. (concluded)

"Art. 54. The exercise of the jurisdiction of the metrological authority, to which Art. 18 of Decree Number 592 of the 4th of August, 1938, refers, shall be delegated in that territory, to any municipal metrological body which solicits it, at the rate of one, as a maximum, for a municipality, whenever that body satisfies the conditions of Art. 60 of the present regulation.

"Sec. 1. The delegating of powers to which this article refers may exclude the exercise of such delegated powers with reference to Federal or State departments and to businesses having Federal or State concessions.

"Sec. 2. The municipal metrological bodies shall not exercise the jurisdiction of authority which is or has been delegated according to Art. 55 and 56 [see below], relative to any manufacturer of measures or instruments of measuring, or to any public utility enterprise.

"Art. 55. The exercise of the jurisdiction of authority to which Art. 19 of Decree Number 592 of the 4th of August, 1938, refers, shall be delegated to any manufacturer of measures or instruments of measuring doing business in the national territory who requests it, whenever that manufacturer satisfies the conditions of Art. 61 of this regulation.

"Art. 56. The exercise of the jurisdiction of authority to which Art. 20 [see page 273] of Decree Number 592 of the 4th of August, 1938, refers, shall be delegated to any public utility enterprise which operates in the national territory, and requests it, whenever that enterprise satisfies the conditions of Art. 62 of this regulation."

Appendix D2. Penalties in Argentina

(Translation of Law No. 845. July 13, 1877.)

"Chapter III"

"Penalties"

"Art. 13. Breaches of this law will be penalized as stated in the following articles:

"Art. 14. Payment of a fine of ten pésos fuértes 1/ will be charged to:

"1. All who make use of weights and measures of the metric decimal system which have not been tested and verified.

1/ The péso fuérte was the national dollar at that time. The present rate of exchange for a peso is 23.90 cents (1941).

"2. All manufacturers who have made weights or measures contrary to Art. 7;

"3. All who make use of weights or measures not of the metric decimal system, being subject also to confiscation of same.

"4. All who present in law-suits documents showing weights or measures different from those which correspond to the metric decimal system.

"Art. 15. Payment of a fine of twenty pésos fuértes will be charged to:

"1. All public employees who make use of weights or measures of any system other than that proclaimed by this law.

"2. All public functionaries who give or permit documents in which weights or measures are expressed in any other system than the metric decimal.

"3. All persons who resist or refuse to present for verification the weights or measures they use.

"Art. 16. Payment of a fine of fifty pésos fuértes will be charged to:

"1. All who make or use fraudulent weights or measures. They are also subject to confiscation of same.

"2. All public scribes, who grant instruments /deeds, and so forth/ containing figuring in other than the metric decimal system of weights and measures established by this law.

"Art. 17. In cases of repetition of the offence the penalties in the above articles will be doubled."

"Quite apart from the above law there are many municipal and other dispositions which bear on the same matter, relating to how the verification and stamping shall be done, costs of same and penalties for infringement including confiscation of weights, machines, or measures; fines and even arrest when a weighing machine, weights, measures (including ordinary litre measures, and so forth) are not denounced.

"There are also national dispositions requiring the presenting of metre measures to the Internal Tax Office for testing and stamping."1/

"In reply to your queries regarding weights and penalties I have had my lawyer look up the law thereupon for you, but before sending it to you I put it before a 'procurador,' who is a man who actually intervenes in getting action in law. This is a recognized profession and very often

1/Legal advisor of a business man in Buenos Aires.

Appendix D2. (concluded)

these smaller men know more about the details of the application of law than the big chaps who just sort of plan cases, but don't do the spade and shovel work of seeing them through. The man laughed when I showed him the copy of the law I will enclose herewith....and he said 'If that were all that there is to it it would soon be said,' (as our native people so naively put it). The law as you will see from the date is 50 or 60 years old but was never put into effect until recent years. Now comes the point. Who is to put it into effect? Well, of course, the local powers who come directly into touch with the uses of weights and measures, and since these beings do not work for nothing and have very little interest in collecting fines for the National Government, they have built up a legislation on the original law which each Municipality or County Council puts into action for its own good, i.e. for as much money as they can squeeze out of the poor merchant. For instance, in this city [Buenos Aires] they have legislated that every 15th of June every year all merchants must send their weights, weighing machines, and measures to a certain office and have them tested and stamped. For this charges are made. After this date the inspectors begin prowling around 'to see whom they may devour' and when they find any weight, machine, or measure without the stamp thereon (no matter if they are up to standard or not) the fine begins to run and is a multiple of what should have been paid for testing the various things. The prices vary according to the sizes and kinds of weighing machines, and so forth. If the merchant still doesn't send along his stuff to be tested and stamped then further fines are levied, which can gradually increase to confiscation of the weights, machines, or measures, or even mean arrest for days or weeks."

The foregoing quotation is from a letter from Mr. Ernest Shepherd, a business man in Buenos Aires. See Appendix G, p. 329.

Appendix D3. Penalties in Uruguay

(Translated from "Sistema Métrico Decimal," Ministerio De Industrias Y Trabajo. Montevideo, Uruguay, 1936.)

"Chapter XII"

"Fines"

"Art. 121. Anyone, who resists, or declines to show to the General Director, Subdirector, Zone and District Inspectors, Departmental Inspectors, and other public officials appointed for the purpose, the weights and measures which he uses in his business, does so under penalty of a fine of 4 pesos [1] for the first time, and 10 pesos for subsequent offences.

"Art. 122. Weights and measures found deficient shall be confiscated, excepting those proved accidently at variance, in which case they shall not be seized, but those possessing them shall be

1/At the present rate of exchange a peso is 46.5 cents (1941).

Appendix D3. (continued)

punished by a fine, not exceeding 50 pesos. Weights and measures used for scientific and professional purposes shall not be included in the above paragraph.

"Art. 123. The offence of an assayer of weights and measures shall be punished by a fine of 2 pesos for each copy, besides the loss by seizure or destruction of the weight or measure found faulty or deficient.

"This penalty shall not be imposed whenever the weight or measure in question shows that it has been examined, and furthermore the merchant possesses a valid certificate that the weights and measures have been regulated, in which case the merchant shall be accorded three days time in which to fulfill the legal requirements.

"The fine which the first paragraph of this article decrees is applicable also to those who violate Art. 10 of Law 6954 and 30 of this ordinance /light, energy, and water meters must be verified/.

"Art. 124. The violation of Art. 46 and 47 /see below/ of this regulation shall be punished by a fine of 10 pesos each time."

"Chapter IV"

"Who Shall Be Obliged to Use Weights and Measures."

"Art. 46. Merchants and those engaged in industry, farmers, cattle dealers, thrashers, harvesters, and so forth, whether in a permanent or transitory business, those in the professions, and without exception all those who engage in a trade, any manufacturing, refinishing, and so forth, which requires the use of weights and measures, shall be obliged to provide themselves with all the necessary metric decimal weights and measures.

"The obligation of providing the weights and measures which the nature of the business requires, applies to distributors for established firms, although it shall not be required of the firms that their merchandise shall be weighed and measured in their main establishments, but each purchase duly put up in tins, packages, bottles or other vessels and marked in Troy pounds shall in each case have the quantity in kilos appear, also the kind of article and its destination.

"Art. 47. Those who ship merchandise, tunned or sacked, or priced according to weight or measurement, shall likewise be provided with the apparatus and necessary measures, notwithstanding that the sales are quoted by bulk, or that the weights and measures have been determined in their respective containers.

Appendix D3. (continued)

"Art. 125. Those who violate the rulings contained in Art. 1, 2, 3 of Law 6954, and 48, 49, 50 [see below], and 51 of the present ordinance shall be punished with a fine of 25 pesos the first time, 50 pesos the second, and 100 pesos the third."

"Chapter V"

"The Use and Mention of Old Measures"

"Art. 48. The use of the metric decimal system of weights and measures, adopted as the only lawful one in the whole Republic by the Law of the 20th of May, 1862, shall be rigidly binding in all civil and commercial transactions whatever may be their nature, as rendering accounts, invoices, market prices, vouchers, receipts, bookkeeping accounts, estimates, publications, advertisements, and in all classes of documents which use or mention weights and measures, be these of official or private nature.

"Art. 50. The use or mention of the equivalents of the old measures is absolutely prohibited, as well as the signs, abbreviations, and anything else which does not correspond to the metric decimal system or is not authorized by the law in force, whenever it treats of actual business operating in the country, making obligatory the indication of the weight or measure, using exclusively the unit multiples or submultiples authorized by that system.

"Notwithstanding in all written documents relative to an estate, whose last measurement or drawing up was dated before the Law of October 2, 1894, it shall be lawful to mention the old measures, reduced to those of the metric decimal system.

"Art. 126. Merchants and those engaged in industry who defraud those with whom they make a contract, giving less quantity than agreed upon, shall be fined 4 pesos the first time, 10 pesos the second, and 25 pesos every subsequent time for each container, package, and so forth, which is deficient.

"Art. 127. When there are several persons who share the responsibility for the violation of these laws, a suitable penalty shall be meted out to each separately, in accordance with the law of the respective rulings.

"Art. 131. Those who violate the order of Art. 15 of Law 6954 and 9 of the present regulation shall be punished with a fine of 10 pesos the first time, 25 pesos the second, 50 pesos the third, and 100 pesos for all subsequent times.

"Art. 15. The importation or local manufacture of balances or steelyards and all utensils of weighing which are not related exclusively

to the metric decimal system is prohibited.

"Those who attempt to introduce manufacture, or have in their possession any weights and measures not authorized, shall suffer, besides the seizure, which the respective authorities shall execute, a fine of 10 pesos the first time, 25 pesos the second, 50 pesos the third, and 100 pesos subsequently.

"Art. 134. The Departmental Inspectors and other officials shall be rewarded for handing the offenders over to the law with 25% of the fines collected.

"Art. 135. The Director General and the Departmental Inspectors shall publish monthly the names and addresses of those who have been fined for selling with false or deficient weights or measures, or have violated the law in any other way.

"Art. 13. The Executive Authority may authorize the use of balances, platform scales, machines of cutting and measuring, packing, and so forth, with the weights or measures marked in the metric decimal system and in any other foreign system contrary to the same, whenever these weighing and measuring or packing machines are used exclusively for exports destined to countries where the metric decimal system is not in force. Likewise, it shall be permitted to designate on the containers of merchandise, in accordance with the conditions of the former clause, the weights and measures in other systems.

"These authorizations shall be of an uncertain character and determined in each case by the Executive Authority.

"Art. 14. In accordance with the decree in the above article and in Art. 44 of Law 6954 cold storage plants shall be authorized to use balances with two kinds of weights (kilograms and pounds) and measuring machines marked in the metric decimal system and in the English system for imported raw materials.

"Manufactured goods for that purpose shall be marked exclusively in pounds or feet.

"Art. 15. Cases of fowl or eggs destined to be exported to countries, where the metric decimal system is not in force also shall be marked in pounds instead of kilograms."

Appendix D4. Penalties in Paraguay

(Translation of Law No. 1430. May 23, 1940.)

"Art. 114. The fees for testing and inspecting weights and measures in general, shall be paid six months in advance by merchants, industrialists, and those in professional work. /The amounts to be paid vary from 30 to 500 pesos legal tender./1/

"Art. 116. The use in general of weights and measures without testing shall be cause for the confiscation of such weights and measures, besides a fine of 500 to 10,000 pesos legal tender, aside from the decrees provided by the Penal Code."

"The Penal Code punishes frauds with penalties, which vary according to the importance of the crime.

"In regard to the number of inspectors, it varies greatly and depends upon the importance of the cities in question. In the Capital there is an office, called the Assayers Bureau, which maintains eight permanent inspectors."2/

1/At the present rate of exchange approximately 80 Paraguayan pesos are equal in value to one Argentine peso or a Paraguayan peso is worth .003 cent (1941).

2/From a letter from Dr. L. Eugenio Codas, a lawyer in Asunción. See Appendix G, p. 331.

APPENDIX E

SUMMARIES OF QUESTIONNAIRE REPLIES RECEIVED BY HALSEY

Appendix E1. Chile

A Summary of Ten Questionnaire Replies Received by Halsey from Chile (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. groceries (see comments 3 and 4) 2. fruit 3. butter and cheese (retail and wholesale) 4. other farm products 5. hardware 6. fish 7. flour 8. tea 9. coffee (retail and wholesale) 10. dry goods (see comment 5) 11. fuel 12. tobacco 13. ready-made clothing 14. hats 15. underwear and hosiery 16. gloves 17. corsets 18. hay (wholesale)	1. meat (retail) 2. lumber and timber (see comment 7) 3. sizes of pipe for gas and water 4. marine (distance) 5. rubber	1. milk (retail and wholesale) 2. meat (live cattle) 3. collars 4. shoes 5. sewer pipe 6. marine (charts of bays, tonnage, displacement, freight, and bulk) 7. railway track gages and length of lines	1. Metric system adopted in 1848--obligatory in 1865. 2. "The addition of the metric system has merely added an additional system without any visible advantage. So long as the Anglo-Saxon dominates in the manufacturing world feet, inches, and pounds will be used here." 3. Groceries: "Generally the libra." (1.01 pound) 4. "The libra [1.01 pound] is most frequently used in the purchase and sale of goods for daily consumption." 5. "Chile has officially adopted the metric system, but in the shops throughout the country the vara [0.91 yard] is still the recognized length for retail selling." (From Part IV of Report by W.A.G.Clark, Commercial Agent of the Department of Commerce and Labor, 1911) 6. "All measures are mixed. Besides metric, avoirdupois weight, and feet, there are many Spanish and local measures like the cajon [6000 pounds], marco [1/2 pound],

[1] Ibid., pp. 15-17.

Appendix E1. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
19. grain (wholesale) 20. root crops (wholesale) 21. garden products (wholesale) 22. rubber (wholesale) 23. carpenters and other woodworkers 24. stone and brick masons 25. mines and mining products 26. smelting and smelter products 27. ship and boat building 28. railway equipment (units used in the construction and repairing of locomotives, cars, and so forth) 29. land 30. machine shops (see comment 8) 31. railway tariff for passengers and freight (load and distance) 32. loads and rates for city transportation 33. contracts for excavation of ground 34. tailors and seamstresses			fanega [1.60 bushel], Spanish quintal [101.40 pounds], and so forth." 7. Lumber and timber: "Sizes as in United States." "Length of native wood in Spanish varas [0.91 yard]." 8. "In machine shops it may be said that up to the present the foot and inch have predominated." "In repair work on English and American machinery, feet and inches; on German, French, and Italian, metric." 9. "The sales of the leading product of this section, nitrate of soda, are made commercially in Spanish quintals [101.40 pounds]." 10. "The Chilian hydrographic charts have scales in several units--cables, meters, and geographic miles."

Appendix E2. Colombia

A Summary of Five Questionnaire Replies Received by Halsey from Colombia (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. groceries 2. fruits 3. butter and cheese (retail and wholesale) 4. other farm products 5. tea 6. coffee (retail and wholesale) 7. dry goods (see comment 4) 8. ready-made clothing 9. hats 10. collars 11. fuel 12. land (farming districts and cities) 13. lumber and timber 14. carpenters and other woodworkers 15. tailors and seamstresses 16. machine shops 17. marine 18. root crops (wholesale) 19. garden products (wholesale) 20. rubber (wholesale) 21. railway track gages and length of lines 22. underwear and hosiery 23. shoes 24. gloves 25. corsets 26. grain (wholesale)	1. fish 2. meat (retail and wholesale) 3. flour 4. tobacco 5. milk (wholesale) 6. land (smaller towns) 7. stone and brick masons 8. mines and mining products 9. sizes of pipe for gas, water, sewers, etc. 10. ship and boat building 11. loads and rates for city transportation 12. loads and rates for transportation by muleback across mountains 13. hardware 14. marine (displacement) 15. smelting and smelter products	1. contracts for excavation of ground 2. railway tariff for passengers and freight (load and distance) 3. milk (retail) 4. marine (freight)	1. Metric system adopted in 1853--obligatory in 1857 for all departments of the government. 2. "As you can see, we have no uniformity of weights and measures in this country." 3. "The pound in this region is the English, because all the machines, platform scales, and weighing instruments come from England and the United States." 4. "Cloths are sold indiscriminately by meters, varas [0.91 yard], or yards according to the origin of the goods or the whim of the buyer."

1/ Ibid., pp. 17-18.

Appendix E3. Costa Rica

A Summary of Three Questionnaire Replies Received by Halsey from Costa Rica (1919)1/ Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. milk (retail)	1. groceries		1. Metric system adopted in 1858--obligatory in 1884 for legal, offificial, and land transactions.
2. meat (retail and wholesale)	2. fruit		2. "Although the law No. 35 of July 17, 1884, established the metric system as obligatory, the people and the merchants do not use it ordinarily in their transactions."
3. ready-made clothing	3. butter and cheese (retail and wholesale)		3. "The people in their [land] transactions generally use the manzana [4.17 acres] and square vara [0.83 square yard], but the registry of documents in the government office is based entirely on the meter and the hectare."
4. collars	4. other farm and garden products (retail)		4. "By carpenters and other woodworkers: Indiscriminately the English foot, the Spanish vara [0.91 yard], yard, and meter."
5. underwear and hosiery	5. hardware		
6. land (agricultural districts, smaller towns, and cities) (see comment 3)	6. fish		
7. lumber and timber	7. flour		
8. carpenters and other woodworkers (see comment 4)	8. tea		
9. tailors and dressmakers	9. coffee (retail and wholesale)		
10. machine shops	10. dry goods		
11. contracts for the excavation of ground	11. fuel (coal, charcoal, and wood)		
12. mines and mining products	12. hats		
13. smelting and smelter products	13. gloves		
14. garden products (wholesale)	14. corsets		
15. railway tariff (freight)	15. ship and boat building		
16. shoes	16. marine		
	17. hay (wholesale)		
	18. grain (wholesale)		
	19. milk (wholesale)		
	20. rubber (wholesale)		
	21. railway tariff (passengers)		
	22. urban transportation		
	23. muleback transportation across mountains		
	24. railway gage		
	25. pipe sizes		

1/Ibid., pp. 18-19.

Appendix E4. Cuba

A Summary of Three Questionnaire Replies Received by Halsey from Cuba (1919)1/ Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. hats	1. groceries	1. tailors and seamstresses	1. Metric system adopted in 1849--obligatory in 1849.
2. collars	2. fruits	2. contracts for excavation of ground	2. "Though the metric system of weights and measures is the official and legal system in Cuba, some of the Spanish weights and measures are still largely used, among them being the arroba [25.35 pounds] and the vara [0.91 yard].
3. underwear and hosiery	3. milk (retail and wholesale)	3. railway tariff for passengers and freight (load and distance)	3. "Cloth is bought by the importer by the meter or yard, and is retailed in the shops by the yard or the vara, the vara being more commonly used." (From Part I of Report by W.A.G.Clark, Commercial Agent of the Department of Commerce and Labor, 1909.)
4. shoes	4. butter and cheese (retail and wholesale)	4. loads and rates for city transportation	4. "American measures generally used, and in each industry the name is used corresponding with the English meaning."
5. gloves	5. other farm products		5. "In the farming districts the measurement of land is by caballeria [33.16 acres], and leagua [3.23 miles], the equivalents being inserted in all public documents according to law."
6. corsets	6. hardware		
7. land (smaller towns)	7. fish		
8. stone and brick masons	8. meat (retail and wholesale)		
9. machine shops	9. flour		
10. mines and mining products	10. tea		
11. smelting and smelter products	11. coffee (retail and wholesale)		
12. ship and boat building	12. dry goods (see comment 3)		
13. railway track gages and length of lines	13. fuel		
14. lumber and timber	14. tobacco		
15. carpenters and other woodworkers	15. ready-made clothing		
	16. land--farming districts and cities (see comment 5)		
	17. sizes of pipe for gas, water, sewers, and so forth		
	18. marine		
	19. hay (wholesale)		
	20. grain (wholesale)		
	21. root crops (wholesale)		
	22. railway equipment (units used in the construction and repairing of locomotives, cars, and so forth (see comment 6)		

1/Ibid., pp. 19-20.

Appendix E4. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
	23. garden products (wholesale)		6. Railway equipment: "American and English equipment."

Appendix E5. Ecuador

A Summary of Five Questionnaire Replies Received by Halsey from Ecuador (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. milk (retail and wholesale) 2. meat (retail) 3. flour 4. dry goods (wholesale) 5. underwear and hosiery 6. shoes 7. gloves 8. corsets 9. land (see comment 5) 10. lumber and timber 11. machine shops (see comment 6) 12. contracts for excavation of ground 13. mines and mining products 14. smelting and smelter products 15. sizes of pipe for gas, water, sewers, and so forth 16. ship and boat building 17. marine	1. groceries (see comment 9) 2. butter and cheese (retail and wholesale) 3. other farm products 4. hardware (pipe, sheet iron and zinc, nails, and tacks) 5. fish 6. tea 7. coffee (retail and wholesale) 8. dry goods (retail) 9. tobacco 10. ready-made clothing 11. carpenters and other woodworkers 12. hay (wholesale) 13. grain (wholesale) 14. loads and rates for city transportation 15. railway equipment (units	1. hats 2. collars 3. tailors and seamstresses 4. meat (wholesale) 5. railway tariff for passengers and freight (load and distance)	1. Metric system adopted in 1856--obligatory in 1856 for official business but not for private. 2. "While the metric system is legal, it is not enforced." 3. "The Spanish pound is used in weighing everything." 4. "The Spanish inch, foot, and ton are used as are other measures, although the metric measurements are sometimes used." 5. "In the cities the buildings are measured by the meter, the lots by the vara." (0.91 yard) 6. In machine shops: "The common standard is the English inch." 7. "The public uses generally the old Spanish (Castilian) measures, the vara [0.91 yard], the libra [1.01 pound], and the gallon [6.69 pints]. 8. "Metric system used in business with foreign

1/Ibid., pp. 20-21.

Appendix E5. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
18. root crops (wholesale) 19. rubber (wholesale) 20. railway track gages and length of lines	used in the construction and repairing of locomotives, coaches, and so forth)		countries, except the United States and Great Britain, in which case the British system is used. 9. "In domestic business only the Spanish system is used." 10. Measuring implements: "Spanish measures chiefly." 11. "Bookkeeping about half in metric and half in old Spanish units but only the latter are used in making out domestic invoices. Foreign invoices about 90% metric, 10% old Spanish [weights and measures]. Business records are about half and half." (Reply to a questionnaire sent out by H. R. Towne)

Appendix E6. Guatemala

A Summary of Four Questionnaire Replies Received by Halsey from Guatemala (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. hats 2. collars 3. blacksmith shops 4. milk (wholesale)	1. groceries 2. butter and cheese (retail and wholesale) 3. fish 4. meat (retail and wholesale) 5. flour 6. tea 7. coffee (retail and wholesale) 8. dry goods (see comment 3) 9. fuel 10. tobacco 11. ready-made clothing	1. milk (retail)	1. Metric system adopted in 1894--obligatory in 1894 for all governmental and departmental work, but not for other purposes. 2. "The artisans of the country use in their calculations the Spanish vara [0.91 yard] as the standard. Foreigners use the yard or the meter indifferently, but the lumber dealer and the dealer in logs sell by thousands of square feet (English)." 3. "The importers usually sell all cloths, that is to say, men's cloths, by the yard.

1/ Ibid., pp. 21-22.

Appendix E6. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
	12. underwear and hosiery 13. shoes 14. gloves 15. corsets 16. land 17. carpenters and other woodworkers (see comment 2) 18. stone and brick masons 19. tailors and seamstresses 20. machine shops 21. contracts for excavation of ground 22. mining and mine products 23. sizes of pipe 24. grain (wholesale) 25. root crops (wholesale) 26. rubber (wholesale) 27. railway tariff (passengers and freight) 28. urban trucking 29. railway track gage		The retailers often and almost solely use the vara [0.91 yard]. The meter is used very little and for the most part only between importers and buyers at wholesale." 4. "The people generally use the Spanish vara [0.91 yard], the cuarta [1.05 pint], and the libra [1.01 pound]. 5. "Metric system generally used in business. 6. "In domestic life the old Spanish measures are generally used. 7. "Weighing scales are sold marked on one side in libras and on the other side in kilograms. 8. "The people continue to use the old Spanish measures from habit and because they know them better than the others. 9. "Our standard of weight is the quintal of 100 Spanish pounds [101.40 pounds]. Our standard of measure is the botella [0.68 quart]." (Reply to a questionnaire sent out by H. R. Towne)

Appendix E7. Mexico

A Summary of Ten Questionnaire Replies Received by Halsey from Mexico (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. milk (retail and wholesale)		1. groceries	1. Metric system adopted in 1862--obligatory in 1865.
2. butter and cheese (retail and wholesale)		2. fruits	2. "In many cases the Spanish weights are used."
3. other farm products		3. fish	3. "In many cases the libra [1.01 pound] and vara [0.91 yard] are used."
4. hardware		4. meat (retail and wholesale)	4. "The old weight, carga [303 pounds], still holds its own when dealing with muleback transportation."
5. flour		5. tobacco	5. "All transportation here is done by boat on a long-ton basis."
6. tea		6. blacksmiths	
7. coffee (retail and wholesale)		7. contracts for excavation of ground	
8. dry goods			
9. fuel			
10. ready-made clothing			
11. hats			
12. underwear and hosiery			
13. shoes			
14. corsets			
15. gloves			
16. land			
17. lumber and timber			
18. carpenters and other woodworkers			
19. tailors and seamstresses			
20. stone and brick masons			
21. machine shops			
22. mines and mining products			
23. smelting and smelter products			
24. sizes of pipes for gas, water, sewers, and so forth			
25. ship and boat building			
26. marine (see comment 5)			
27. hay (wholesale)			
28. grain (wholesale)			
29. root crops (wholesale)			
30. garden products (wholesale)			
31. rubber (wholesale)			

1/ Ibid., pp. 23-24.

Appendix E7. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
32. railway tariff for passengers and freight (load and distance) 33. loads and rates for city transportation 34. loads and rates for transportation by muleback across mountains (see comment 4) 35. railway track gages and length of lines 36. railway equipment (units used in the construction and repairing of locomotives, coaches, and so forth)			

Appendix E8. Nicaragua

A Summary of Three Questionnaire Replies Received by Halsey from Nicaragua (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. groceries (see comments 2, 3, and 6) 2. milk (retail) 3. hardware 4. flour 5. dry goods (see comment 5) 6. ready-made clothing 7. hats 8. collars 9. underwear and hosiery 10. land 11. tailors and seamstresses	1. butter and cheese 2. other farm products 3. fish 4. meat (retail) 5. tea (see comment 3) 6. coffee (retail and wholesale) 7. fuel 8. tobacco 9. lumber and timber 10. carpenters and other woodworkers 11. stone and brick masons 12. contracts for excavation of ground 13. mines and mining products	1. shoes 2. railway tariff for passengers and freight (load and distance) 3. loads and rates for city transportation 4. railway track--length of lines (see comment 5)	1. Metric system adopted in 1893--obligatory in 1893. 2. "The metric system of weights and measures is the official and lawful system of the Republic, but owing to the preponderance of trade with the United States, the influences of the system obtaining there are felt in all commercial transactions." 3. "The introduction of all imports is based

1/ Ibid., pp. 24-25.

Appendix E8. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
12. machine shops 13. meat (wholesale) 14. butter and cheese (wholesale)	14. smelting and smelter products 15. sizes of pipe for gas, water, sewers, and so forth 16. grain (wholesale) 17. root crops (wholesale) 18. milk (wholesale) 19. rubber (wholesale) 20. loads and rates for transportation by muleback across mountains 21. railway track gages 22. railway equipment (units used in the construction and repairing of locomotives, cars, and so forth)		on the kilo, but throughout the Republic articles are retailed by the libra /1.01 pound/. 4. "Liquids when imported are measured by the liter, yet the American gallon or quart is commonly known. 5. "Distances are computed in kilometers, but the yard of 36 inches is used almost as much as the vara of 33 inches or the meter of 39.37 inches. 6. "So it might be said that the English system is almost as common as the metric."

Appendix E9. Panama

A Summary of Five Questionnaire Replies Received by Halsey from Panama (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. ready-made clothing (see comment 4) 2. hats (see comment 4) 3. collars (see comment 4) 4. underwear and hosiery (see comment 4) 5. shoes (see comment 4)	1. groceries (see comment 2) 2. fruits 3. milk (retail and wholesale) 4. butter and cheese (retail and wholesale) 5. other farm products 6. hardware 7. fish 8. meat (retail and wholesale) 9. flour (see comment 3)	1. land (see comment 2)	1. Metric system adopted in 1853--obligatory in 1857 for governmental and official use. 2. "The Spanish units are never used here, and while the metric system is the official standard for the country, with the exception of lands, it is seldom used in

1/Ibid., p. 25.

Appendix E9. (concluded)

I, Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
6. gloves (see comment 4) 7. corsets (see comment 4) 8. carpenters and other woodworkers 9. stone and brick masons (see comment 5) 10. tailors and dressmakers (see comment 6) 11. machine shops 12. contracts for excavation of ground 13. ship and boat building	10. tea 11. coffee (retail and wholesale) 12. dry goods 13. fuel 14. tobacco 15. lumber and timber 16. sizes of pipe for gas, water, sewers, and so forth 17. marine 18. hay (wholesale) 19. grain (wholesale) 20. root crops (wholesale) 21. garden products (wholesale) 22. rubber (wholesale) 23. railway tariff for passengers and freight (load and distance) 24. loads and rates for city transportation 25. railway track gages and length of lines 26. railway equipment (units used in the construction and repairing of locomotives, cars, and so forth)		Panama, American (English) standards of weight and measure being in universal use." 3. Flour: "Barrel of 196 pounds." 4. Ready-made clothing, hats, collars, underwear and hosiery, shoes, gloves, corsets: "The articles mentioned are imported almost exclusively from the United States and the measures are the same as in that country. A few French articles are metric sizes." 5. By stone and brick masons: "American generally." 6. By tailors and dressmakers: "American generally."

Appendix E10. Peru

A Summary of Seven Questionnaire Replies Received by Halsey from Peru (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. milk (retail)	1. hardware	1. groceries	1. Metric system adopted in 1862--obligatory in 1916 for all commercial firms.
2. butter and cheese (retail and wholesale)	2. land--farming districts (see comment 5)	2. tobacco (government monopoly)	2. "The metric system is the legal system in Peru, but the other measures named have not yet been banished."
3. other farm products	3. lumber and timber	3. ready-made clothing	3. "At the present time there are many who buy and sell, using other measures which are not metric decimal."
4. fish	4. coffee (wholesale)	4. collars	4. "Although the country has officially adopted the metric system, cloth is always retailed by the vara [0.91 yard]." (From Part IV of Report by W.A.G.Clark, Commercial Agent of the Department of Commerce and Labor, 1911)
5. meat (retail and wholesale)	5. garden products (wholesale)	5. corsets	5. "Sale and registry [land] by the fanegada [1.59 acre]."
6. flour (see comments 2 and 3)		6. contracts for excavation of ground	6. In machine shops: "English system chiefly. A few jobs for European-built machinery are handled on the metric system."
7. tea		7. milk (wholesale)	7. Sizes of pipe for gas, water, sewers, and so forth: "Generally English feet and inches and their
8. coffee (retail)		8. loads and rates for city transportation	
9. dry goods (see comment 4)		9. railway track gages and length of lines	
10. fuel			
11. hats			
12. underwear and hosiery			
13. shoes			
14. gloves			
15. land--smaller towns and cities (see comment 5)			
16. carpenters and other woodworkers			
17. stone and brick masons			
18. tailors and seamstresses			
19. machine shops (see comment 6)			
20. mines and mining products			
21. smelting and smelter products			
22. sizes for pipe for gas, water, sewers, and so forth (see comment 7)			
23. ship and boat building (see comment 8)			
24. marine (see comment 9)			
25. hay (wholesale)			

1/ Ibid., pp. 25-27.

Appendix E10. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
26. grain (wholesale) 27. root crops (wholesale) 28. rubber (wholesale) 29. railway tariff for passengers and freight (load and distance) 30. loads and rates for transportation by muleback across mountains 31. railway equipment (units used in the construction and repairing of locomotives, cars, and so forth)			fractions." 8. In ship and boat building: "Generally the English measures." 9. Marine measurements: "Generally the English measures."

Appendix E11. San Salvador

A Summary of One Questionnaire Reply Received by Halsey from San Salvador (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. tailors and seamstresses 2. railway tariff for passengers and freight (load and distance)	1. groceries 2. butter and cheese (retail and wholesale) 3. other farm products 4. hardware 5. fish 6. meat (retail and wholesale) 7. flour 8. tea 9. coffee (retail and wholesale) 10. dry goods 11. fuel 12. collars 13. land--farming districts and smaller	1. milk (retail) 2. land--cities (see comment 2) 3. contracts for excavation of ground	1. Metric system adopted in 1885--obligatory in 1885 for official use; in 1912 for all public and private transactions. 2. "In the farming districts /the measurement of land is by/ manzana /4.17 acres/ and caballeria /33.16 acres/; in the smaller towns /by/ vara, with metric measures always used in the documents." 3. "Practically all exported yarn is put up in either five or ten-pound paper-covered packets and either eighty or forty

1/Ibid., p. 28.

Appendix E11. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
	towns (see comment 2) 14. stone and brick masons 15. sizes of pipe for gas, water, sewers, and so forth 16. grain (wholesale) 17. milk (wholesale) 18. loads and rates for city transportation 19. loads and rates for transportation by muleback across mountains		of these packed to the bale. Yarn is retailed here in ten-pound lots, but two five-pound packets are preferred to one ten-pound....These splits are 20 to 26 inches wide, and retail at a 'real' a vara [0.91 yard]. (From Part I of Report by W.A.G. Clark, Commercial Agent of the Department of Commerce and Labor, 1909)

Appendix E12. Spanish Honduras

A Summary of Three Questionnaire Replies Received by Halsey from Spanish Honduras (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. milk (retail) 2. land (see comment 6) 3. tailors and seamstresses 4. mines and mining products 5. railway tariff for passengers and freight (load and	1. groceries 2. fruits 3. butter and cheese (retail and wholesale) 4. meat (retail and wholesale) 5. flour 6. tea 7. coffee (retail and wholesale) 8. dry goods (see comments 3 and 9) 9. fuel 10. tobacco 11. ready-made clothing (see comment 4) 12. hats (see comment 5) 13. collars (see comment 5)	1. milk (wholesale)	1. Metric system adopted in 1897--obligatory in 1897. 2. "All articles not named above are valued according to agreement per arroba or carga, always keeping the English as the standard. The arroba is 25 pounds and the carga is 8 arrobas or 200 pounds." 3. "The English yard is chiefly used in the larger and better stores. The vara [0.91 yard] is used frequently in smaller stores selling at retail to certain classes, but the people are accustomed

1/*Ibid.*, pp. 28-29.

Appendix E12. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
distance) 6. railway track gages and length of lines	14. underwear and hosiery 15. shoes (see comment 5) 16. gloves (see comment 5) 17. corsets (see comment 5) 18. lumber and timber (see comment 7) 19. carpenters and other woodworkers 20. stone and brick masons 21. machine shops 22. contracts for excavation of ground 23. smelting and smelter products 24. sizes of pipe for gas, water, sewers, and so forth 25. ship and boat building 26. marine 27. hay (wholesale) 28. grain (wholesale) 29. root crops (wholesale) 30. garden products (wholesale) 31. rubber (wholesale) 32. loads and rates for transportation by muleback across mountains 33. railway equipment--units used in the construction and repairing of locomotives, cars, and so forth (see comment 8)		to and demand the English yard." 4. Ready-made clothing: "Same as in United States." 5. Hats, collars, underwear and hosiery, shoes, gloves, corsets: "American and French sizes." "General American sizes of wearing apparel in use." 6. "The official standard [land] is the hectare. Deeds in hectares and others in manzanas [4.17 acres] according to original measure. In towns the lots are measured in English feet and are so registered. Also large parcels in the country measured in caballerias [33.16 acres]." 7. Lumber and timber: "Exactly the same as American sizes." 8. Railway equipment: "English units are used in repairs." 9. "The importers sell to the retailers by the yard and the retailers sell at practically the same price by the vara [0.91 yard].... 10. "This country has officially tried to adopt the metric system, but the natives cling to the vara [0.91 yard] and the arroba [25.35 pounds] as their measures of length and weight." (From Part I of Report by W.A.G. Clark, Commercial Agent of the Department of Commerce and Labor, 1909)

Appendix E13. Venezuela

A Summary of Five Questionnaire Replies Received by Halsey from Venezuela (1919)[1] Showing the Items for which both Customary and Metric Units Are Used; the Items for which Customary Units Are Used Exclusively; the Items for which Metric Units Are Used Exclusively; and the Comments Made by Those Who Answered the Questionnaires.

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
1. groceries (see comments 2 and 3) 2. fruits 3. milk (retail) 4. butter and cheese (retail) 5. other farm products 6. hardware 7. fish 8. meat (retail and wholesale) 9. flour 10. tea 11. coffee (retail) 12. dry goods 13. fuel 14. ready-made clothing 15. hats 16. collars 17. underwear and hosiery 18. shoes 19. corsets 20. land 21. lumber and timber 22. carpenters and other woodworkers (see comment 4) 23. tailors and seamstresses 24. stone and brick masons 25. machine shops 26. sizes of pipe for gas, water, sewers, and so forth 27. ship and boat building (see comment 5)	1. gloves 2. sugar land	1. tobacco 2. contracts for excavation of ground 3. mines and mining products 4. smelting and smelter products 5. hay (wholesale) 6. root crops (wholesale) 7. coffee (wholesale) 8. milk, butter, cheese (wholesale) 9. loads and rates for city transportation 10. loads and rates for transportation by muleback across mountains 11. railway track gages and length of lines	1. Metric system adopted in 1857--obligatory in 1912. 2. "Not only is it illegal to use any other weights and measures (than those of the metric system), but a merchant is subject to punishment for having them in his possession. The importation of weights and measures other than the legal is also prohibited, and as the authorities have destroyed the old ones, wherever possible, distinct progress toward the universal adoption of the new system has been made. In spite of the stringency of the laws the people at large, especially in the country, still cling to the old units in their everyday life, and talk and think in terms of them." 3. "The people in the interior of the country are not at all accustomed to the metric system, and always use the old system." 4. By carpenters and other woodworkers: "Some carpenters do actually work in English inches." 5. In ship and boat building: "In navigation and geography miles are used;

[1] Ibid., pp. 30-31.

Appendix E13. (concluded)

I. Customary and Metric	II. Customary (exclusively)	III. Metric (exclusively)	IV. Comments
28. marine 29. grain (wholesale) 30. railway tariff for passengers and freight (load and distance) 31. railway equipment--units used in the construction and repairing of locomotives, cars, and so forth (see comment 6)			for the rest, metric." 6. Railway equipment: "Inches on English lines; metric units on German railway."

Appendix E14. Reports

A report in 1911 by W. A. G. Clark, Commercial Agent of the United States Department of Commerce and Labor states that, "Bolivia has officially adopted the metric system, but the old Spanish weights and measures are those commonly used. All cloth is retailed by the vara [0.91 yard]."1/

"Commerce Reports" (February 20, 1918) states that, "The metric system of weights and measures has been legally adopted by the Dominican Republic. The only places, however, where the metric system is applied to trade here is in the municipal markets; avoirdupois weights are used in all other mercantile transactions, although the metric system is in force in the customs and other government institutions. The kilometer and the league [3.23 miles] are the two units most generally used in computing distances. Jobbers use the English yard in selling cotton goods to the retailers, while the latter in turn sell to their customers by the vara or Spanish yard, measuring 33 inches. While quotations may be made by American houses to their clients in the Dominican Republic in either metric or English units, the latter are equally acceptable, if not preferred."2/

"Factors in Foreign Trade" (1912) states that in Haiti the metric system has been adopted, "but pounds, tons, and gallons are generally used in commerce and statistics. The pound of 500 grams (1.1023 pound avoirdupois) is adopted in the customs; the ton is 2000 pounds; the gallon is equivalent to the United States gallon."3/

A report of investigations by F. S. Holbrook, Associate Physicist at the United States Bureau of Standards, of weights and measures in Porto Rico states that, "A little over 50% of the weights found in use were of the Spanish system, the remainder being about equally divided between the weights of the metric

1/Ibid., p. 14.

2/Ibid., p. 20.

3/Ibid., p. 22.

Appendix E14. (concluded)

system and our /English/ customary system. Of the liquid measures tested, the very great majority were cuartillos /1.06 pint/ or subdivisions thereof." The legal standards are United States, a few Spanish, and metric, and the measuring implements in common use are both United States and metric. The metric system was adopted by Porto Rico in 1898.1/

1/Ibid., p. 27.

APPENDIX F

PHOTOGRAPHS TAKEN IN SOUTH AMERICA BY THE INVESTIGATOR

Loading Two-arroba (approximately 65 pounds) Paneiros (baskets) of Sugar onto the Amazon River-boat Bom Jardim, Pará, Brazil July 2, 1939

Appendix F. (continued)

Cargo on the S.S. Belém
Two-arroba (65 pounds) Paneiros (baskets) of Sugar,
53 gallon Barrels of Motor Gasolene, and
55 gallon Barrels of Texaco Petroleum.
Amazon River, Brazil
July 2, 1939

Loading Wood for Fuel on the Amazon River-boat
The sticks are 4 palmos (approximately 35 inches) long.
Floresta, Pará, Brazil
July 2, 1939

Appendix F. (continued)

Selling Water
The measure is a twenty-gallon gasoline can.
Santarém, Pará, Brazil
July 5, 1939

Open-air Market at Dawn
The cabócles are selling from their canoes
to the highest bidders (at the right).
Manáos, Amazonas, Brazil
July 11, 1939

Appendix F. (continued)

Open-air Market on the Quay at Dawn
Belém, Pará, Brazil
July 14, 1939

One-eighth Alqueire (approximately 1/2 peck) Paneiros (baskets) of Tomatoes

Paneiros (baskets) of Charcoal--Large, Medium, Small

Appendix F. (continued)

Loading 100 Pound Bags of Bran[1]
Rio de Janeiro, Brazil

Loading 60 Kilo (132.6 pounds) Bags of Coffee
Rio de Janeiro, Brazil

[1] This picture and the others of the same size were taken by Palmer Pictures, 90 West Street, New York City. The writer bought them on the S. S. Brazil en route from Buenos Aires.

Appendix F. (continued)

Unloading Crates of 100 Argentine Apples
Rio de Janeiro, Brazil

Crates of Fruits and Vegetables
Rio de Janeiro, Brazil

Appendix F. (continued)

Milk by the Litro, (1.06 quart)
1/2 Litro, and 1/4 Litro
Rio de Janeiro, Brazil

Appendix F. (continued)

The Mercado Municipal (City Market)
São Paulo, Brazil
July 31, 1939

Jacas of Cheeses (14 to 16 in each jaca)
Stall of Domingos Albino, Rua C, 13

Grapes are Sold by the Half-kilo (1.10 pound)
and Pears are 200 Réis Cada (each)

Appendix F. (continued)

Some Store Window Displays in São Paulo, Brazil

A Balanza de Familia (household weighing machine)
The weight is recorded in both Portuguese libras and onzas
(pounds and ounces) and metric kilos and grams.
Mappin's Department Store
Rua Barão De Itapetaninga
August 2, 1939

Men's and Women's Handkerchiefs by the 1/2 Duzia (dozen)
Casa Lemcke
Rua Libero Badaro, 303
August 3, 1939

Appendix F. (continued)

Oranges by the 1/2 Duzia (dozen)
Fructaria Paulista--a Fruit Store
Rua Anhaugabahu, 113, São Paulo, Brazil
August 3, 1939

Flowers by the Duzia (dozen)
São Paulo, Brazil

Appendix F. (continued)

A Santos Fruit Stand
Grapes by the Kilo (2.2046 pounds);
Apples and Pears by the Cada (each)

Baskets of Vegetables
Santos, Brazil

Appendix F. (continued)

A Store Window Display in Buenos Aires, Argentina
De Manuel Rivas

Candy by the 1/4 Kilo
Confiteria y Panaderia (confectionery and bakery shop)
Calle Callão, 1631
August 22, 1939

Appendix F. (continued)

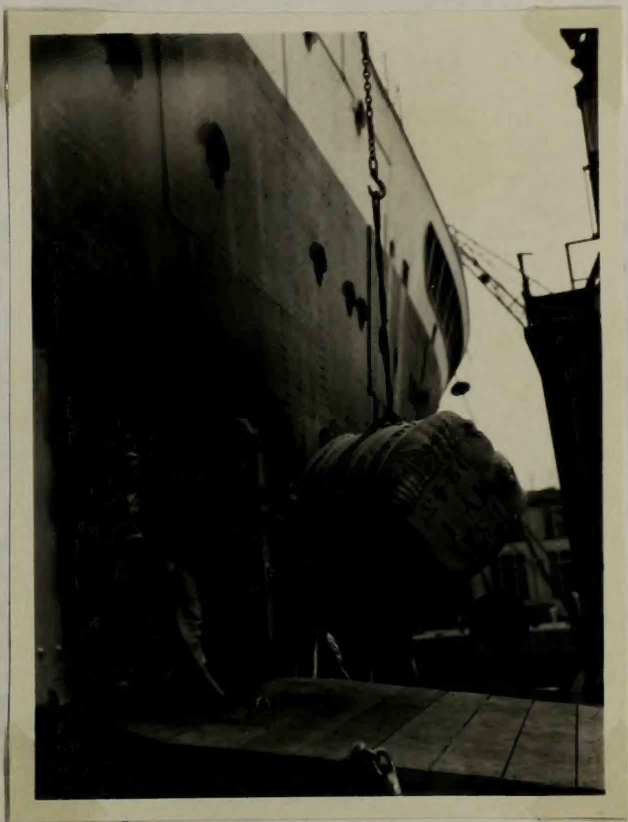
Loading Fardos (bales of 550 pounds) of Wool
Buenos Aires, Argentina

A Fardo (bale of 200 kilos)[1/] of Bran
Buenos Aires, Argentina

1/200 kilos (440 pounds).

Appendix F. (concluded)

Una Pesada[1] in Use for Hides
Buenos Aires, Argentina



Loading a Fardo (bale of 550 pounds) of Wool
The weight of a fardo may vary as much as 50 kilos (110 pounds)
as there is no standard.
Montevideo, Uruguay

1/Una pesada--dry hides (35.45 pounds); salted hides (60.77 pounds); washed sheepskins (30.38 pounds).

APPENDIX G

CORRESPONDENCE

Appendix G1.

(Copy)

WORLD FEDERATION OF EDUCATION ASSOCIATIONS

Eighth Biennial Congress, August 6-11, 1939
Rio de Janeiro, Brazil

Office of the Secretary-General
1201 Sixteenth Street, N. W.
Washington, D. C.

November 14, 1938.

Miss Gertrude Yorke,
146 Commonwealth Ave.,
Boston, Mass.

My dear Miss Yorke:

Answering your letter of November 12th, I am afraid that I shall not be able to give you much firsthand information on whom to see in Brazil. So far as getting in touch with the manufacturing, industrial and commercial concerns, I suggest that you write to the Commercial Attaché of the Brazilian Embassy here in Washington. Or, better still, if you are in the city sometime, it might be well for you to see him in person and explain what it is you wish and why you are going to Brazil.

I would like to have you meet Dr. Gustavo Lessa whose address is Caixa Postal 1805, Rio de Janeiro. Dr. Lessa has been in this city for some time and just recently returned to Rio, having been a fellowship student at Brookings Institute here. He is a very fine person, speaks excellent English and most certainly is interested in education. While you wouldn't expect him to act as an interpreter, he would put you in touch with the right people, I am sure. You might mention that I recommended your seeing him; for I know him quite well.

Sincerely yours,

(Signed) Edna V. Cowell,
Assistant to the Secretary-General.

Appendix G2.

(Copy)

THE AMERICAN RED CROSS
National Headquarters
Washington, D. C.

November 17, 1938.

Miss Gertrude C. Yorke,
146 Commonwealth Avenue,
Boston, Massachusetts.

My dear Miss Yorke:

Your letter of November 12th addressed to Mr. Gard has been referred to Insular and Foreign Operations for attention. I am sorry to say the American Red Cross no longer has representatives in foreign countries and consequently we cannot completely comply with your request. We are however, listing below the addresses of the National Red Cross Societies of Chile, Argentina and Brazil:-

Chile:	Calle Catedral, 1572 Santiago de Chile
Argentina:	Calle Juncal, 1635 Buenos Aires
Brazil:	Praça da Cruz Vermelha, 10-12 Rio de Janeiro

I am certain if you contact the above named societies they will be very glad to be helpful to you in securing interpreters.

Sincerely,

(Signed) Antoinette E. Hardisty,
Assistant to Vice Chairman,
Insular and Foreign Operations.

Appendix G3.

(Copy)

SABIN ST. GERMAIN, INC.
21 West Street
New York, N. Y.

December 3, 1938.

Miss Gertrude Yorke,
146 Commonwealth Ave.,
Boston, Mass.

Dear Miss Yorke:

We wish to refer to your letter of November 12th, and wish to apologize for not writing you sooner.

We have carefully gone over our records regarding the Brown & Sharpe Precision Instruments shipped to the Latin-American countries, and we find that the English measures predominate three to one over the Metric measures. In some instances the customer specifies both English and Metric.

Our Mr. St. Germain is in South America at the present time but upon his return your letter will be brought to his attention, and we are sure he will be very glad to give you personal letters of introduction to our associate dealers in Brazil, Argentina, and Chile.

If there is any additional information you may require, please do not hesitate to communicate with us.

Yours very truly,

Sabin St. Germain, Inc.
(Signed) Elena Felici,
Vice President.

Appendix G4.

(Copy)

THE FOREIGN SERVICE
OF THE
UNITED STATES OF AMERICA

American Consulate General,
Rio de Janeiro, Brazil,
December 3, 1938.

Miss Gertrude Yorke,
146 Commonwealth Avenue,
Boston, Massachusetts.

Madam:

I have for acknowledgment your letter of November 12, 1938, stating that you are planning to come to Brazil next February to engage in research regarding the use of the metric system in the trade and industry of this country and requesting letters of introduction to such persons as might be able to furnish you with the information you desire.

Consular officers are forbidden by their regulations to issue letters of introduction to private persons, but should you care to communicate with this office upon your arrival at Rio de Janeiro, an effort will be made to place you in touch with those Brazilian officials who may be in a position to give you the desired information.

The present system of weights and measures in this country is governed by two decrees, namely, Nos. 592 of August 4 and 886 of November 24, 1938, published in the "Diário Official" of August 16 and November 24, respectively. You may wish to consult the Brazilian Consul at Boston in this regard, in the hope that he may permit you to consult the publication mentioned.

Assuring you that this office will be pleased to assist you further, I am,

Respectfully yours,

(Signed) William C. Burdett,
American Consul General.

Appendix G5.

(Copy)

THE FOREIGN SERVICE
OF THE
UNITED STATES OF AMERICA

American Consulate General,
Buenos Aires, Argentina,
December 9, 1938.

Miss Gertrude Yorke,
146 Commonwealth Avenue,
Boston, Massachusetts.

Madam:

Reference is made to your letter of November 12, 1938, regarding your intention to come to Argentina for the purpose of doing research on metric usage in trade and industry.

It is suggested that the National Office of Weights and Measures, Paseo Colon, 974, Buenos Aires, might be in a position to give you certain desired information. The Consulate General will be pleased to assist you in any way possible upon your arrival here.

Very truly yours,

For the Consul General:
(Signed) C. M. Ravndal,
American Consul.

Appendix G6.

(Copy)

Rio, December 28th, 1938.

Miss Gertrude Yorke,
Boston.

My dear Miss Yorke:

As I was out for some days your letter of November 25th only recently reached me.

Before making arrangements for your interpreter I must know: the date of your arrival; the number of days of your stay here; the boat on which you will come.

I don't think it will be difficult to get one. I don't offer myself because it is likely that I shall be in vacation at that time.

If by chance the matter is not straightened out by letters, when you shall arrive here please call in the afternoon at the office of the Brazilian Association of Education:

Associacão Brasileira de Educacão
Avenida Rio Branco, 91 (10th floor)

(The Brazilian usage is to put the number after the name of the street.)

There they will tell you the way of getting in touch either with myself or with Dr. Harry C. Tucker, Miss Lois Williams, Miss Consuelo Pinheiro. Any one will gladly help you.

With the best wishes, I am

Very sincerely yours,

(Signed) Gustavo Lessa

Dr. Gustavo Lessa,
Caixa Postal 1805,
Rio, Brasil.

Appendix G7.

(Copy)

NATIONAL EDUCATION ASSOCIATION OF THE UNITED STATES
1201 Sixteenth Street, N. W., Washington, D. C.

December 31, 1938.

Miss Gertrude C. Yorke,
146 Commonwealth Ave.,
Boston, Mass.

Dear Miss Yorke:

In response to your request of December 18, I am enclosing a certificate of your membership in the National Education Association which I hope may be of help to you in receiving courtesies while you are visiting in South America and particularly during the Rio Conference.

With best wishes for a fine trip, I am

Very cordially yours,

(Signed) Willard E. Givens,
Executive Secretary.

Enclosure

Appendix G7. (concluded)

(Copy)

NATIONAL EDUCATION ASSOCIATION OF THE UNITED STATES
1201 Sixteenth Street, N. W., Washington, D. C.

January 3, 1939.

To Whom It May Concern:

This is to certify that Miss Gertrude C. Yorke is a member in good standing of the National Education Association of the United States.

Any courtesies which you may find it possible to extend Miss Yorke will be deeply appreciated by our Association.

Very cordially yours,

(Signed) Reuben T. Shaw,
President.

(Seal)

(Signed) Willard E. Givens,
Executive Secretary.

Appendix G8.

(Copy)

BOSTON UNIVERSITY
SCHOOL OF EDUCATION
Boston, Massachusetts

84 Exeter Street

May 18, 1939.

To Whom It May Concern:

This letter is given to Miss Gertrude Yorke as a means of introduction and identification in connection with a South American trip for the study of weights and measures in industry in metric countries of South America.

Any courtesy which you may show Miss Yorke will be greatly appreciated.

Sincerely,

(Signed) Guy M. Wilson,
Professor of Education.

Appendix G9.

(Copy)

AMERICAN INSTITUTE OF WEIGHTS AND MEASURES
33 Rector Street
New York

May 22, 1939.

To Whom It May Concern:

This will introduce Miss Gertrude Yorke, a student in the School of Education of Boston University, Boston, Mass. Miss Yorke is visiting South America to study the uses of weights and measures in industry. She is an earnest student who is deeply interested in this subject.

I shall be pleased if her studies in South America may be facilitated by anyone who can give her educational assistance.

(Signed) W. R. Ingalls,
President.

Appendix G9. (concluded)

(Copy)

AMERICAN INSTITUTE OF WEIGHTS AND MEASURES
33 Rector Street
New York

August 1, 1940.

Miss Gertrude Yorke,
146 Commonwealth Ave.,
Boston, Mass.

Dear Miss Yorke:

Replying to your letter to me under date of July 31:

Under separate cover I am sending you a copy of the Hearings on H. R. 10 of the Sixty-ninth Congress, which will give you what you want. You need not return this book to us, for we have several copies of it.

H. R. 10 died with the Sixty-ninth Congress. Since that time there has not been introduced any avowedly prometric bill, but there have been introduced some measures of a prometric flavor that have had to be opposed by us.

Yours very truly,

(Signed) W. R. Ingalls,
President.

Appendix G10.

(Copy)

BOSTON UNIVERSITY
SCHOOL OF EDUCATION
84 Exeter Street
Boston, Massachusetts

Office of the Dean

This is to certify that

MISS GERTRUDE CUSHING YORKE

has been officially appointed to represent

BOSTON UNIVERSITY
SCHOOL OF EDUCATION

at the Conference of the

WORLD FEDERATION
OF
EDUCATIONAL ASSOCIATIONS

(Signed) Jesse B. Davis, (Seal)
Dean.

June 3, 1939.

Appendix G11.

(Copy)

BENCE TOURIST COMPANY

South American Branch Office
Alvear Palace Hotel
Buenos Aires
Argentina

331 Madison Ave.
at 43rd Street
New York
22 Julio, 1939.

Sr. Paul Pellecq,
Gerente General,
Alvear Palace Hotel,
Buenos Aires, Arg.

Presentando la Señorita Gertrude C. Yorke.

Distinguido Señor:

Tengo el agrado de presentarle a la Srta. Gertrude C. Yorke, de quien yo le he ya escrito.

Cualquiera cortesía prestada sería muy reconocida por su muy atta.

(Signed) S. v. de Bence, President,
BENCE TOURIST COMPANY.

Appendix G12.

(Copy)

Buenos Aires, November 19, 1939.
O'Higgins 1452.-

My dear Miss Yorke:-

Thank you very much for your letter dated September 9th (from Trinidad) which I received about two weeks ago; but as I have been absent from this city for a major period of time, I have not been able to answer at an earlier date for which delay I sincerely apologise.- The other letter you mention has not been received sofar.-

After having been informed by Mr. Memmuir about the conversation he has had with you, I started to go immediately into the matter of your interest in order to let you know already definite results.-

As regards Indian weights and measures in Paraguay, as far as I know and according to my very minute investigations with experts on the life and habits of the Guaraní, Cainguá, Guayaquies and the Chaco (Macá, Lengua, etc.) tribes, there are none and have never been any specific or specially named weights or measures, but only rough estimates and general indications such as "a man's" or "a child's weight," "a day's trip" etc. The same refers to most of the Indians and nearly all of the South and Central American tribes, except those belonging to the old Inca-, Aztec- and Maya-groups and their off-springs.- I myself am not an expert on this matter although knowing very well Indian tribes and customs in many South-American countries, but after having received Mr. Memmuir's information, I have immediately established contact with those who are and who have confirmed my above statements.-

There are of course, as you probably know, in nearly all the South and Central American States, still some ancient Spanish and Iberian measures in use, which I shall be glad to let you have if you would want me to do so. In the Argentine, p.e., there are still some very old weights in use for Hides and Sheepskins, such as:-

"Una pesada" of dry hides	=	35.448105 (Engl.)	lbs.
"Una pesada" " salted hides	=	60.76818 "	"
"Una pesada" " washed sheepskins	=	30.38409 "	"

There are many other weights and measures still widely used, such as cuarta, frasco, galón, baril, etc. for liquids; and cuartilla, fanega, etc. for dry capacity; also lineal and customary measures. The same refers to all the other South and Central American countries.-

As to Paraguay there are also still many old weights and measures used in the country, some of them nearly forgotten such as the "liño" a land measure which is equivalent to 75 square metres, or the "almuda" for salt and grains,- etc.etc.

Appendix G12. (concluded)

Having now established my personal residence and centre of business activities in the Argentine (Buenos Aires), I am in a position to give you full details regarding old South and Central American weights and measures still in use in the different countries.-

This information will be gathered from experts and from the most reliable sources available at the different University and State Libraries.-

The total charge for this work will be $ U.S. 100 (one hundred U.S. Dollars) to be remitted in cheque (giro) on one of the big bankers here, made out to my order.-

Endeavouring to comply with your indications (points N°1 to 5), I shall specify wherever possible; name of the weight or measure, its equivalent in metres, yards, etc., where used, for what products, and used to what extent.-

In the case you should accept my offer and remit the forementioned amount, I hope to be able to finish the work within 2-3 weeks time after your confirmation, under my personal responsibility and indicating the different sources and literature.- The type-written text and amount of copies you should require, will be sent to you by airmail.-

Should you prefer so, I would suggest that you instruct the American Consulate here or any other institution or private person to pay the above mentioned sum against my delivery of the work.-

As to any other information or indication which would not require a thorough research work or contact with experts and specialists, I shall be only delighted to let you have free of charge.-

Yours very sincerely,

(Signed) Dr. F. G. Weiss,
O'Higgins 1452,
BUENOS AIRES, R.Argentina.

Appendix G13.

(Copy)

SHEPHERD & CIA.
Representantes De
COATES BROTHERS
& COMPANY LIMITED
Fabricantes de Tintas y Barnices para las
Artes Graficas, Especialistas en Accesorios
para Imprentas

Bdo. De Irigoyen 844 Buenos Aires

April 24, 1940.

My dear Miss Yorke:

Your letter dated 7th. March is to hand and Gwendolyn just had time to read it before she went off on a holiday up north. She asked me to thank you very much for all the trouble you have taken over her request and that she will send a letter direct to the people you kindly mention.

In reply to your queries re. weights and penalties I have had my lawyer look up the law thereupon for you, but before sending it to you I put it before a "procurador" who is a man who actually intervenes in getting action in law. This is a recognized profession and very often these smaller men know more about the details of the application of law than the big chaps who just sort of plan cases but don't do the spade and shovel work of seeing them through. The man laughed when I showed him the copy of the law I will enclose herewith (together with a free translation for you) and he said "If that were all that there is to it it would soon be said," (as our native people so naively put it.) The law as you will see from the date is 50 or 60 years old but was never put into effect until recent years. Now comes the point, Who is to put it into effect? Well of course the local powers who come directly into touch with the uses of weights and measures, and since these beings do not work for nothing and have very little interest in collecting fines for the National Government, they have built up a legislation on the original law which each Municipality or County Council puts into action for its own good, i.e. for as much money as they can squeeze out of the poor merchant. For instance in this city they have legislated that every 15th of June every year all merchants must send their weights, weighing machines, and measures to a certain office and have them tested and stamped. For this charges are made. After this date the inspectors begin prowling around "to see whom they may devour" and when they find any weight, machine or measure without the stamp thereon (no matter if they are up to standard or not) the fine begins to run and is a multiple of what should have been paid for testing the various things. The prices vary according to the sizes and kinds of weighing machines &c. If the merchant still doesn't send along his stuff to be tested and stamped then further fines are levied, which can gradually increase to confiscation of the weights, machines or measures or even mean arrest for days or weeks.

Appendix G13. (concluded)

The Instituto Biológico Argentino you refer to cannot possibly use anything but metric weights as far as their sales of goods are concerned as they, just like any other merchant, come under the laws I have referred to. Now for their inside use for making up their prescriptions and patent medicines they are free to use any measures they favour, and if their formulas are in British weights and measures it would not be surprising that they worked to this system, but when the goods are to be placed on the market they MUST adhere to the law.

I have no direct means of finding out how these people work but when Gwendolyn returns from her holiday I will ask her if she knows anyone there so as to make enquiries for you, but perhaps what I have told you above will be sufficient for your purposes.

I noticed in our native paper La Nacion yesterday that there is a very interesting article about Miss Grace Abbot and her remarkable work in connection with the Government Dept. of Child Welfare, reference being made to a publication named "The Child," presumably an official publication widely known. If copies of this can be procured I should think they would be particularly illuminating for Gwendolyn.

Now I will run off a translation of the enclosed papers for you and get this to the post so that you may have it at as early a date as possible.

Again thanking you for your kind help and with happy memories of you in Iguazu, with the little chorus drumming in my ears,

"Zú Zú Iguazú, Ra Ra Guayra."

Yours sincerely,

(Signed) E. S. Shepherd

P.S. In case you or some friend be interested in stamps I will put one of the new special issue on this letter.

Appendix G14.

(Copy)

Dr. L. Eugenio Codas
Asunción-Paraguay

Julie 12 de 1940.

Señorita GERTRUDE YORKE,
Commonwealth 146. BOSTON,
MASSACHUSETTS.

Mi distinguida amiga:

Con gran placer he recibido su estimada carta del 23 de Mayo, de cuyo contenido quedo impuesto.-

Su exquisita amabilidad y gentileza hace que Ud. recuerde con placer su visita a Asunción, pues, en puridad de verdad muy poco hemos contribuido para que Ud. lo pasara conforme debia, pero sea como fuere, le que damos desde luego muy gratos.-

Evacuando su amable consulta, debo informarle lo que sigue: La ley No. 1430 de fecha 23 de Mayo de 1940, establece en sus arts. pertinentes lo que sigue:
Art. 114.- Las tasas por contraste e inspección de pesas y medidas en general, seran abonadas, por semestre adelantado por los comerciantes, industriales y profesionales, en la siguiente forma: (Vienen las cantidades a pagarse que fluctuan entre 30 a 500 pesos de curso legal.- Serian de 10 centimos a 1.50 dollars).- Esto es por semestres adelantados.-
Art. 116.- El uso en general de pesas y medidas sin las contrastación en general motivará el comiso de esas pesas y medidas, ademas de una multa de $ 500 a $ 10.000 de c/legal, sin perjuicio de las sanciones previstas por el Código Penal.--
Y el C. Penal, sanciona los fraudes con penas que fluctuan segun la importancia del delito.-

Respecto del número de inspectores, debo informarle que, varia mucho y depende de la importancia de la Municipalidad respectiva.- En la capital hay una Oficina llamada de Fiel Contraste y tiene 8 inspectores permanetes.-

Mr. White, oportunamente me acusó recibo de la encomienda que su amabilidad hizo que llegara a su poder y luego personalmente me la agradeció en oportunidad de su visitá a esta ciudad, en Febrero último.-

Deseo crea sinceramente, que tendriamos mucho placer en tenerla de nuevo muy pronto, en la seguridad que la proxima vez, le haremos pasar mejor, ya que estamos aprendiendo con gran interes el ingles.-

Mi Sra. agradece especialmente su amable saludo y le retribuye, haciendo votos por que siga Ud. muy bien y con mucha felicidad.-

Tenga en cuenta, que sus cartas me proporcionan gran placer y que en espera de ellas quedo., reiterandole una vez mas que soy su amigo y obsecuente servidor.-

(Signed) L. Eugenio Codas

Juan de Zalazar 10.

Appendix G15.

(Copy)

UNITED STATES
DEPARTMENT OF THE INTERIOR

Geological Survey
Cooperating with
Public Service Commission of Wisconsin

666 State Office Building,
Madison, Wisconsin,
August 28, 1940.

Miss Gertrude Yorke,
146 Commonwealth Avenue,
Boston, Massachusetts.

Dear Miss Yorke:

Your letter of August 20 to Mr. G. P. Steinmetz, Public Service Commission of Wisconsin, Madison, Wisconsin, in regard to the gage at the Lower Dells has been referred to me.

The gage is one which we operate for the purpose of continuously recording the stage of the Wisconsin River. It is equipped with a float-actuated pencil which marks the river height continuously on a strip of cross-section paper traveling at a uniform time rate by means of a clock mechanism. A diagrammatic sketch of the inside arrangement and instrument is shown in a view sent herewith.[1/]

The purpose of collecting stage records is to obtain the volume of daily discharge of the Wisconsin River at this point. The discharge of a stream is obtained by applying the daily stage record to a rating curve which defines the relation between stage and discharge. The rating curve is plotted from the results of discharge measurements made by our engineers using a current meter from the suspension cable and car which you may have noticed a short distance downstream from the Lower Dells gage. Records of daily discharge for this station and for 3,830 other gaging stations in the United States are published yearly in the U. S. Geological Survey Water Supply Papers. There is a district office of the U. S. Geological Survey in Boston, 945 Post Office Building, where you may consult the Water Supply Papers and obtain further information about our work.

Our gages are in principle similar to the Nilometer of Egypt [2/] only we obtain, in addition, the volume of stream flow. You may be familiar with

1/See Appendix A, pp. 205 and 206.

2/See Appendix A, p. 204.

Appendix G15. (concluded)

Miss Gertrude Yorke - 2. August 28, 1940.

the description of the Nilometers contained in the proceedings of the American Society of Civil Engineers. These publications are indexed and give references to source data. While technical publications are largely concerned with fluctuations in stages of rivers or lakes, I have seen some very detailed descriptions of the Egyptian gages in these articles.

I am having a couple of prints made of the Wisconsin Dells gage and will forward them to you when they return.

Should you desire further information, I would be glad to be of service.

Yours very truly,

(Signed) F. C. Christopherson,
District Engineer.

APPENDIX H

DOCUMENTARY EVIDENCE

Advertisement for a Farm.

From O Estado De São Paulo, Brazil

August 3, 1939.

FAZENDA PARA CRIAÇÃO

Compra-se uma fazenda para criação, localisada na linha de Central (ramal de S. Paulo), de 300 a 400 alqueires mais ou menos. Cartas ou pessoalmente com o sr. LUCIANO, A Praça Patriarcha n.º 1 (A Exposição). (6312)

Attend

SEGURO MORREU DE VELHO...

jewels

buys gold diamonds

Seja prudente, concerte sua finas joias, occulos e relogios numa casa de CONFIANÇA, como é A INDIANA, que alem concertar com perfeição, dá cartão de garantia por UM ANNO. A INDIANA compra ouro at 21$000 a gramma e brilhantes até 5:000$000 o quilate.

A INDIANA compra prata em moedas e objectos, joias, relogios, antiguidades, etc. Paga-se mais 30 por cento.

A INDIANA Rua das Laranjeiras, 20. Phone: 6095.

FOLHA DA MANHA —

Casa de Belchior "A Indiana"

RUA DAS LARANJEIRAS, 20

COMPRA E VENDE objectos usados, como sejam: Cofres, machinas Singer, photographicas, de escrever, joias, relogios, binoculos, capas, moveis de Jacarandá. Antiguidades em louças, crystaes, marphim, etc. Salvas, casticaes, bandeijas de prata. Lustres e casticaes de vidro. Ouro-velho até 21$000 a gramma, prata quebrada ou em moedas. Brilhantes até 5:000$000 o quilate, e tudo mais que tenha valor commercial. Nada venda sem consultar as nossas offertas, pois pagamos mais 30 por cento.

"A INDIANA" rua das Laranjeiras, 20 — Phone: 6095.

old gold

= 3.07 grains

TURF — As corridas de amanhã no Jockey Clube de Pernambuco

Um interessante "meeting" será realisado amanhã, na pista da Magdalena. Sob o patrocinio do *Jockey Clube de Pernambuco*.

Essa conhecida e tradicional agremiação turfistica organisou um programma caprichoso, constando de cinco pareos, onde actuarão os melhores "cracks" das nossa pistas.

O quarto pareo, com dotação de 800$000, num percurso de 1.600 metros é o de maior repercussão e está despertando o mais vivo interesse nos circulos turfisticos do Estado.

O programma está assim elaborado:

1.° Pareo — 1.250 metros (13.30 horas) — Premio — FIRMEZA — Premios: 500$000 e 50$000 — Pirulito, Porangaba, Aceguá e Negrita.

2.° Pareo — 1.250 metros (14.05 horas) — Premio — POTOSI — Premios: 500$000 e 50$000 — Polyana (1), Potosi, Motim e Fuxico.

3.° Pareo — 1.500 metros (14.40 horas) — Premio — NELLY — Premios: 600$000 e 60$000 (Betting) — Chibata, Xilena, Condor e Ceu Azul.

4.° Pareo — 1.600 metros (15.15 horas) — Premio — ARACY — Premios: 800$000 e 80$000 (Betting) — Favorita, Andaya, Aracy e Olinda.

5.° Pareo — 1.400 metros (15.50 horas) — Premio — FAVORITA — Premios: 700$000 e 70$000 (Betting) — Lagarta, Rep. Argentina, Fita e Sagaz.

RECIFE, 15 — 7 — 1939

INEDITORIAES

AOS INDUSTRIAES

land

Vende-se pela metade do seu real valor, importante terreno com cerca de 44.000 metros quadrados, terrenos promptos para edificação, solidos e arborizados e situados no coração do progressista bairro industrial de Afogados.

P. R. A. 8

12 horas — Ave Maria... Boletim de informações officiaes.

12 e 15 — Programma da tarde — Musica escolhida.

13 e 45 — Jornal da tarde da PRA-8.

STUDIO

18 horas — Quarto de hora com Rivaldo Lopes: — E' pra casar! — embolada de João Galhardo e Rivaldo. Mané Corá — jongo de Raul Torres. Quero ver virar! — embolada de Josemar Ribeiro.

19 e 15 — Quarto de hora com a soprano Iracema Baptista: — Tuas mãos — valsa de Julio do Carmo, palavras de Ziul Mattos. Retalhos d'alma — valsa de Milton Amaral. Beijo — de Eugenio Orfeo.

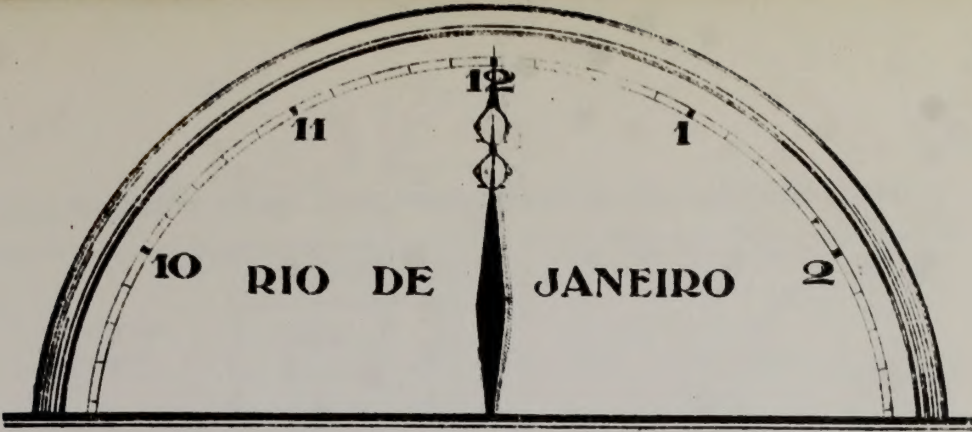
Folha da Manhã

edição das 16 horas

Propriedade da FOLHA DA MANHA S. A. — Director-presidente: ARTHUR DE MOURA

ANNO II | Recife, sabbado, 15 de julho de 1939 | N.° 405

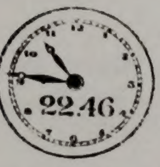
Pernambuco, Brazil



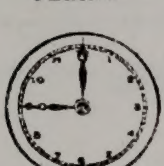
LEGAL TIME

BERLIN - VIENNA
ROME

MOSCOW



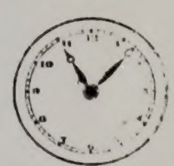
PEKING



CHICAGO

MEXICO CITY

NEW-YORK



BUENOS AIRES

PARIS - LONDON
LISBON

THE regulation for the carrying out of the law of June 18th 1913, which established legal time in Brazil in accordance with the system of zone times sought a better and more uniform distribution of time throughout the country by means of a convenient demarcation of time limits. Legal time for the whole of Brazil, in force since January ist 1934, is the same as that of Rio de Janeiro (zone time — 3 hours), with the exception of the States of Amazonas and Matto Grosso, a portion of the State of Pará, the Acre, the Archipelago of Fernando Noronha and the island of Trinidad.

a) Amazonas was divided into two parts by a line (maximum circle) starting at Tabatinga and running to Porto Acre. To the east of this line legal time is given by the zone time of — 4 hours, to the west by that of — 5 hours; the above two towns being included in the eastern part (— 4 hours).

b) In Matto Grosso legal time is given by the zone time of — 4 hours.

c) In Pará legal time is the same as in Rio, with the exception of that section bounded by a line running from Monte Crevaux, on the French Guyana frontier as far as the Amazonas, and to the south, by the bed of the Xingú, to the edge of the State of Matto Grosso. Throughout all this part of the State, legal time is at the zone time of — 4 hours.

d) In the Acre, legal time is given by the zone time of — 5 hours and in the Archipelago of Fernando Noronha and the island of Trinidad, by the zone time of — 2 hours.

LEGAL TIME IN RIO — Legal time in Rio de Janeiro is 7m.6s.4 behind Greenwich time. The National Observatory broadcasts Rio's legal time twice a day, at 11 a.m. and 9 p.m. For local information and for the use of ships in the harbour, signal lights are transmitted from the signal tower of the São Januario hill.

From
"Brazil - statistics
Resources
Possibilities"
Ministry of Foreign Affairs,
Commercial Service.
Rio de Janeiro, 1937.

CULTIVATED AREA AND PRODUCTION OF COTTON DOWN

PRODUCING STATES	1934/1935 (Actual		1935/1936 (Estimate)		1936/1937
	Cotton, Raw (Ton.)	Area cultivated (hectares)	Cotton Raw (Ton.)	Area cultivated (hectares)	Cotton Raw (Estimated) Ton
Pará	1.054	10.550	2.499	25.000	2.200
Maranhão	7.803	73.362	9.999	76.000	9.000
Piauhy	6.486	33.372	9.980	46.000	4.000
Ceará	31.375	278.889	45.000	357.000	25.000
Rio G. do Norte	27.052	140.145	39.000	145.000	20.000
Parahyba	39.898	222.896	60.000	251.000	30.000
Pernambuco	27.420	182.832	30.000	200.000	25.000
Alagôas	15.902	106.013	22.050	56.000	11.000
Sergipe	6.217	34.539	8.000	44.000	5.000
Bahia	5.499	45.833	8.100	67.000	8.500
São Paulo	98.206	393.294	120.000	404.000	205.000
Paraná	4.599	17.037	3.900	15.000	8.700
Minas Geraes	8.000	50.000	15.000	94.000	35.000
Other States	148	493	1.000	5.000	3.700
TOTAL IN BRAZIL.....	279.659	1.588.755	375.428	1.785.000	392.000

NOTE: — Equivalent, in bales of 500 lbs. to: 1.252.230 — 1934/1935.
1.630,000 — 1935/1936.

COTTON PRODUCING ZONES

From "Brazil - Statistics, Resources, Possibilities"
Ministry of Foreign Affairs,
Commercial Service.
Rio de Janeiro, 1937.

PRODUCTION OF COTTON IN THE STATE OF SÃO PAULO

TYPES

TYPES	N.º of Bales		Kilos		Percentage	
	1935	1936	1935	1936	1935	1936
1	258	—	41.277	—	0,04	—
2	4.440	3.391	727.727	566.746	0,74	0,32
3	26.964	90.837	4.545.996	15.655.054	4,63	8,85
4	71.650	299.316	12.053.155	51.893.366	12,27	29,35
5	174.831	361.383	29.509.184	62.615.427	30,05	35,41
6	161.648	182.204	27.135.810	31.460.924	27,63	17,80
7	89.790	60.946	14.994.579	10.447.918	15,27	5,91
8	38.801	18.175	6.506.893	3.097.025	6,62	1,75
9	12.823	4.742	2.126.787	802.186	2,17	0,45
Less than 9	3.494	1.641	569.461	272.765	0,56	0,16
TOTAL......	584.699	1.022.635	98.206.868	176.910.111	100,00	100,00

The minimum fibre registered during the above fortnight was 27/28 millimetres and the maximum 33/34 millimetres.

All classification from this date onwards will be considered as the crop of the agricultural year 1936/37.

PER ZONE

ZONES	1935/1936		1936/1937			Number of planters
	Area under cultivation in alqueires	Production in arrobas per alqueire	Seeds distributed Kilos	Area under cultivation in alqueires	Percentage incrase in relation to 1935/36	
First	53.168	126,3	93.405	78.870	48,3	9.629
Second	38.761	109,1	82.970	65.772	69,6	17.762
Third	23.580	121,1	45.287	37.483	59,8	3.087
Fourth	26.542	138,9	55.696	51.812	95,2	4.675
Fifth	70.302	140,3	134.461	119.035	69,3	9.767
Sixth	35.397	111,8	55.073	52.320	47,8	5.391
Seventh	42.884	128,9	79.725	76.117	77,4	8.435
Eighth	19.878	107,6	28.276	27.718	39,4	2.262
TOTALS	310.512	123,0	574.890	509.137	63,9	61.908

Remarks: — This statistical data was furnished direct by the planters in the act of buying the seeds.

(1) 1 *alqueiro* in S. Paulo = 24,200 Ms.² = 6 acres.

From
"Brazil - Statistics,
Resources,
Possibilities."
Ministry of Foreign Affairs,
Commercial Service.
Rio de Janeiro, 1937.

LAND

20 WORDS, PER DAY, $1.70

BEST part of Beccar, P. Uriburu corner Acassuso, ground plot 450 vs. to be sold. Two sqs. from station; U.T. 67-7711. 380418

REAL ESTATE FOR SALE

21 WORDS, ONE DAY, $1.70. TWO. $2.90, THREE, $3.70

QUINTA house in Olivos, J. Ingenieros 1695, very comfortable, garage, ground 43 x 60 vs. for sale with facilities. U.T. 741-2179. 3763 12

TEMPERLEY

SANTA MARIA DE ORO 16-68

Luis Keldory

Temperley: in front of station 30 minutes from Constitución New boarding house, just opened in park of 1800 varas. 10 front bedrooms (S. and D.). big diningroom (separate tables) lounge and library all beautifully furnished. plenty hot water, excellent board and all modern conveniences. Boarders have the option of having meals in the centre, at Lavalle 477 Run by same Management Apply Lavalle 477 8o. piso. 110

Sept. 1, 1939.

vara = 2.84 feet or 8.07 square feet

LAND

20 WORDS, PER DAY, $1.70

IN Villa Ballester, F.C.C.A., 10,000 sq. vs. of ground to be sold with shade and fruit trees, in one lot or divided into fractions. Situated in General Paz, Republica and Libertad streets. Facilities for payment. Terms Independencia 1125, City.

BELGRANO. Martínez corner Echeverría, ideal ground-plot 14.84 x 13.75 vs. Will sell urgently. Property Administration, F. Grimaldi, Florida 229, office 31. h26yh28

TO LET ample English chalet in Villa Devoto, Pareja 4256/74, four squares from station. Comfortable reception rooms, five bedrooms, two bathrooms, garage, 3,200 sq. vs. splendid old garden. Can be visited from 13 to 17 hours. Further details U.T. 70-6916. 3199 h29

L. DARMSTADTER AND Co. Reconquista 330 - U.T. 31-5979 and 1533

3 Very Nice Properties in Olivos

WINEBERG (5 sq. from BORGES): modern, first class constr. with 7 principal rooms, 2 bathr., winter-garden, pretty garden (780 sq. varas), garage, ctl. heating, etc., etc. A bargain.

CATAMARCA (4 1|2 sq. from BORGES): excellent chalet with a large ground of 1,580 sq. varas, a very nice reception floor, garden, garage; 4 bedr., 2 bathr., etc., etc.; really cheap.

Beautiful Plots of Ground in Martínez

AV. AGUIRRE corner AV. PARANA: 2 plots of 870 and 425 sq. vs., resp.

JUAN de GARAY corner DGO. REPETTO: 1 or 2 very nice lots, with big trees and an area of 1,630 or 4,100 sq. vs., resp.

In the Best Localities of San Isidro

BARRIO-PARQUE "AGUIRRE" (Labardén betw. E. Echeverría and J. Hernández): plot of ground of 730 sq. vs. (with 23 varas frontage); a real bargain!

BARRIO-PARQUE "BALCARCE" (López and Planes betw. J. Rivera Indarte and J. C. Paz): 1, 2 or 3 plots of ground, with a total area of 1,825 sq. vs.; cheap.

BARRIO-PARQUE "VIVOT" (Perú corner J. C. Paz), 2 sq. from "Las Barrancas" st., nice plot of ground of 1,090 sq. vs.

We have furthermore on private sale, very many other plots of ground, chalets and garden-houses, located between VICENTE LOPEZ and SAN ISIDRO, at any prices. h27yh29

MODERN ONE-STORY CHALET

Large, in north Liniers. Above Versailles (F.C.O.) station, Calle Bruselas 1021|23, between Marcos Sastre and Noyoga. 30 minutes from Plaza Mayo by the F.C.O. Colectivos 11 and 21 and omnibus 31 within a few yards. 20 varas by 26. Garden, fruit trees, 6 rooms, built-in- cupboards and book-cases, shutters, installed bath, kitchen. Detached garage lavatory and wash-house. Asphalt pavement. Immediate occupancy. — Base price $11,800, including mortgage of $9,000. Can be seen from 14 to 18 o'clock. — José María Bacigalupi. — On Sunday, September 3 at 16 o'clock.

LAND SALES

L. Darmstadter and Company have sold privately the property 25 de Mayo 656-66 with measurements of 17.32 by 32.90 metres (578.42 square metres) at the price of $72,000 cash.

Sept. 1, 1939.

From Buenos Aires Herald
Argentina
Aug. 28, 1939.

GRAIN MARKETS

With a general improvement in prices Maize closed steady and seed firm.

GRAIN SHIPMENTS

	Wheat	Maize	Linseed	Oats
U.K.	12,710	7,388	9,026	—
Cont.	15,977	12,194	9,380	299
Orders	31,066	26,890	8,081	2,818
Brasil	15,635	—	—	—
U.S.A.	—	30	—	—
Canada	—	—	—	—
Various	—	40	—	—
Totals	[illegible]	46,842	26,[illegible]	3,117

	August 25 to August 31	Corresponding period 1938	1937
Wheat	75,388	37,066	26,527
Maize	45,542	88,669	181,819
Linseed	26,437	18,757	18,125
Oats	3,117	8,584	3,905
Totals	150,484	152,076	230,376

The estimate of visible supplies was as follows:

Maize . . . . . . 330,000 tons
Linseed . . . . . 100,000 „

Morning transactions.

MAIZE.—
Sept. — 6.10|08|07|08.
Oct. — 6.16|18|22|28|22|18.
Nov. — 6.28|25.
Dec. — 6.30|35|32|31|30.

LINSEED.—
Sept. — 14.40|42|45|46|40|43.
Oct. — 14.45|47|48|50|52|53|50|49.
Nov. — 14.40|45|39.

SUNFLOWER.—
Sept. — 13.55|60|65.
Oct. — 13.60|65.

Afternoon transactions.

MAIZE.—
Sept. — 6.07|06|08.
Oct. — 6.15|18|21|22.
Nov. — 6.24|22|25|28.
Dec. — 6.30|28|26|30|31.

LINSEED.—
Sept. — 14.45|51|55.
Oct. — 14.52|53|56|55|58|60|65|67.
Nov. — 14.47|50|55.

SUNFLOWER.—
Sept. — 13.82.

OFFICIAL PRICES IN BS. AIRES

Wheat

	Yest.	Prev.
Spot	8.—	7.—

delivery was quoted at £71.0.0; for delivery within 90 days at £71.0.0. Foreign antimony for immediate delivery was quoted at £55.0.0 duty paid.

NEW YORK, Aug. 31

Lead (spot) . . . . . at 5.09
Zinc (spot) . . . . . „ 5.06
Copper (electrolytic) „ 10.50
Copper (foreign), at 10.62½|10.67½.

North American silver in the market to-day was 36½ cents per oz.

Antimony 13
Bismuth 110

SUGAR MARKET

NEW YORK, Aug. 31

The following were the sugar quotations at the close of market, in cents per pound:

September 2.03
November 2.07
January 1.98

(Quoted in shills. and pence per hundredweight)

LIVERPOOL, Aug. 31

September 6/9
December 6/1
March 6/1½

RUBBER MARKET
(Quoted in cents per pound)

NEW YORK, Aug. 31

Lt. Ribsmoked sheet . . at 16.81
Standard Thinlatex . . „ 18.50
Standard Thicklatex . . „ 19.31
Acre fine . . . . . . „ 14.50
Up-river . . . . . . „ 14.37

HIDE MARKET

NEW YORK, Aug. 31

The closing quotations in the market to-day were:

August 10.38
September . . . 10.66
December . . . 11.—

LIVE STOCK MARKET

AT LINIERS

Entries 8,067
Previous surplus 253
Total 8,320

as follows: 12 steers of 461 kilos at $0.276 1|0 of 489 at $0.276; 23 of 511 at $0.265.

Purchases: Grondona 71; Smithfield 98; La Blanca 452; Wilson 472; Anglo 583; Armour 368; Swift 728; Sansinena 402; Corp. Argentina (Consump.) 828; Corp. Argentina (Export.) 1,103.

Steers 450 to 500 ks.	0.258	0.276
„ over 500 ks.	0.252	0.265
„ heavy fat cong.	0.23	0.246
„ fat Continent	0.22	0.24
„ 300-450 kilos	0.188	0.252
„ 380-450 kilos	0.21	0.24
„ spec. 450-500 ks.	0.175	0.206
„ heavy and fat	0.16	0.184
„ canning (sup.)	0.11	0.116
„ „ (inf.)	0.10	0.106
„ spec. 260-300 ks.	0.25	0.316
„ gen. and fat meat	0.21	0.23
„ over 320 kilos	0.24	0.25
„ gen. and fat meat	0.196	0.226
„ 260-300 kilos	0.25	0.316
„ gen. and fat meat	0.21	0.23
„ over 320 kilos	0.22	0.264
„ gen. and at meat	0.19	0.205
„ 200-250 kilos f.	0.28	0.346
„ meat	0.23	0.26
„ 140-190 ks.	0.30	0.366
„ gen. and fat meat	0.245	0.27
„ spec. 80-190 ks.	0.38	0.458
„ reg. and fat meat	0.—	0.—
Young bulls and calves	0.20	0.24
„ fat canning	0.10	0.12

AT AVELLANEDA

Entries 32,896
Previous surplus 4,994
Total 37,890

Purchases: Smithfield 2,839; Wilson 2,544; Anglo 4,365; Swift 3,414; Armour 4,615; La Blanca 2,583; Sansinena 752; Corp. Argentina 3,299.

Wethers up to 50 kilos	11	14	10.60	12.—
„ up to 55 ks.	14	16	7.70	10.50
„ canning	—	—	—	—
Ewes over 60 ks.	09	13	8.50	11.30
„ (butcher)	09	13	5.70	8.10
„ canning	17	22	8.—	10.50
Lambs (frig.)	—	—	6.—	7.60
„ (butcher)	—	—	8.30	12.20

PIGS

Entries 2,136
Previous surplus —
Total 2,136

Capones 80 to 60 ks.	0.415	0.432
„ fat type 90-110 ks.	0.42	0.446
„ semi fat	0.37	0.40
General for consump.	0.33	0.39
Inferior type	0.—	0.—

From Buenos Aires Herald Argentina Sept. 1, 1939.

Type E	unq.	unq.
Type F	unq.	unq.
New Cotton — seasonal type per ton placed at:—		
Pte. Saens Peña	160.—	167.—
Resistencia	unq.	205.—
Villa Angela	unq.	unq.
Las Breñas	$167.—	$167.—
Corrientes	unq.	170.—
Formosa	$145.—	$145.—

FOREIGN MARKETS

SHIPMENTS (tons.)

	This week	Last week	Same week last year
DANUBE—			
Wheat	14,152	11,639	3,919
Maize	218	1,959	2,395
Barley	—	—	12,519
Wheat	—		
RUSSIA—			
Maize	—	—	—
Barley	—	6,895	35,380

France, Wheat. — Exports have been prohibited from France as also from North Africa except to France.

Sales. — Rosafe 79.88 k. Wheat en route to Liverpool 18|9 ($6.46). Plata Maize arrived at Liverpool 24|- ($8.27), due at London 24|3 ($8.35) and en route to London 23|7½ ($8.14).

Quotations. — Parcels African White No. 2 Maize August Liverpool 22|6 ($7.75) sellers.

Parcels Rosafe 79.88 k. Wheat Aug.|Sept. Liverpool 18|9 ($6.46) sellers.

COTTON MARKET

The following were yesterday's cotton quotations on the Liverpool market per lb.:—

	Yesterday	Previous
October	4.72d.	4.58d.
Equivalent per kilo	$0.65	$0.63
December	4.71d.	4.55d.
Equivalent per kilo	$0.65	$0.63
March	4.71d.	4.56d.
Equivalent per kilo	$0.65	$0.63

NEW YORK, Aug. 31.

The closing quotations in cents per pound on the cotton market to-day were:—

Spot 8.91
October 8.41
December 8.25
January 8.12
March 8.08
May 7.96

METAL MARKET

LONDON, Aug. 31

The following prices were quoted: (Quotations are sellers price):

Lead English standard
for spot . . . . . at 16.10.0
do for 90 days . . „ 16. 5.0
Tin English standard
for spot . . . . . „ 230. 0.0
do for 90 days . . „ 226.15.0
English Standard copper, for spot . . . „ 44.17.6
do for 90 days . . „ 45. 5.0
Electrolytic copper for
spot . . . . . . „ 52. 0.0
do for 90 days . . „ 53.10.0
Zinc English standard
for spot . . . . . „ 15. 3.9
do for 90 days . . „ 15. 2.6

Silver was quoted at 19 1/16d. per ounce.

English antimony for immediate

Appendix H. (concluded)

LINN & CIA. Pag. No. 31.

LIBRO DE PRECIOS

Calle Galicia, 1041
Montevideo, Uruguay Fecha: 27 de Agosto de 1937.-

Seccion: MOLINOS Y TORRES. "Fairbanks-Morse"

M O L I N O S.

No. 8	Diametro de Rueda 2.45 Mts.	$ 150.00
10	" " 3.05 "	225.00
12	" " 3.66 "	405.00
16	" " 4.90 "	800.00

T O R R E S.

No. 2E - 30	Altura 9.15 mts.	145.00
2E - 40	" 12.20 "	192.00
2E - 50	" 15.25 "	285.00
3E - 20	" 6.10 "	125.00
3E - 30	" 9.15 "	175.00
3E - 50	" 15.25 "	345.00
4E - 20	" 6.10 "	250.00
4E - 30	" 9.15 "	290.00
4E - 40	" 12.20 "	375.00
4E - 50	" 15.25 "	485.00

Indicadores de Deposito	3.00
Frenos Automáticos	20.00
Juegos de placas y tornillos para No. 8 & 10	3.50
" " " " 12	4.50
" " " " 14 & 16	6.00

DESCUENTO............E

Latas de aceite para molinos 4.50 Neto.

Esta Pagina Anula La No. 31 De Fecha 21 Setiembre 1936.-

APPENDIX I

TRANSFER OF PROPERTY

Transfer of Property, Number Three Hundred and Forty-five.
June 24, 1931, Asunción, Paraguay.

(Copy and Translation from the Correspondence of the American Consulate, Asunción, Paraguay, 1937, Vol. 4, Classes 852-866.18.)

"In Asunción, Paraguay, on the twenty-fourth of June, one thousand nine hundred thirty-one, before me, Calixto F. Gonzalez, Notary Public, came: the party of the first part, the Seller, married, accompanied by her husband, Dr. (the Seller's husband), who came to present the certificate of marriage for this act and, as proof of it, he also shall subscribe (this document), residing at Calle Presidente Eligio Ayala, No. three hundred twenty-three; and the party of the second part, Mr. (the Buyer), married, German, residing at Presidente Franco and Chile Streets; and Mr. (the Mortgager), married, Argentine, residing at Calle Palma, No. five hundred four also came; all those appearing are residents of this neighborhood, of age, competent, to my knowledge. Dr. (Seller's husband) has complied with the electorial law in force, which I certify, and Mrs. (Seller) deposes and says that she sells and transfers to Mr. (Buyer) two parcels of land, including all that which is built, attached, and planted, situated in this Capital, in this district of San Roque, section called 'Salinares,' on Calle Tercera Nueva, between Samuhú Peré and Primera Nueva, of the following dimensions and boundaries. First Parcel: designated as Lot No. one of Block D. It fronts on the west on Calle Tercero, today known as Calle Dr. Manuel Pérez, measuring ten meters, thirteen centimeters, and the same at the rear; bounded on the east by the property of Don Gregorio Gómez; its depth on both sides measures forty-four meters, two hundred ninety-five millimeters; and is bounded on the north by the property of Mrs. Irene Zárate de Sánchez, now of the Schoreder and Pastore Society and on the south by the property of Don Luis Magrini. Surface: four hundred and forty-eight square meters, five square decimeters. Second Parcel: consisting of parts of Lots Nos. two, three, and four of the same Block D. Its frontage on Calle Tercera, now Calle Dr. Manuel Pérez, (al Oeste Mide 22.4 pies--veintidos pies con cuetro pulgadas--treinta centivaras) on the west measures twenty-two feet, four inches, (22.4 ft.), thirty centivaras, or seven meters, one hundred eighty-eight millimeters, and the same at the rear; bounded on the east by the property of Don Gregorio Gómez and Lot No. thirteen of Mr. Federico A. Perrett. Its frontage on both sides measures forty-four meters, two hundred ninety-five millimeters and is bounded on the north by the rest of the parcel of Schoreder and Pastore, and on the south by Lot No. one of Mr. Perrett. That is to say, adjoining the first parcel. Surface: three hundred eighteen square meters, three thousand nine hundred twenty-five square centimeters. The property thus circumscribed belongs to Mrs. (Seller) by gratuitous donation of her aunt, in writing given before Notary

Public Abelardo Brugada, dated the tenth of December, one thousand nine hundred and twenty-four, it having been acquired by the donor through purchase from Miss Edith I. Insfrán by the same instrument mentioned and of which testimony exists in the Register of Properties of the District of San Roque, folio one thousand two hundred and seventy-six, et sequitur, of the year of this grant. This instrument was cleared by the grantee under date of June twenty-third, one thousand nine hundred and twenty-five before the above-mentioned Notary, and duly noted in the same year in folio eight hundred and ninety-six, et sequitur. Miss Edith I. Insfrán, who came by the property through purchase from Mr. José I. Meza, according to the deed executed on the twentieth of January of one thousand nine hundred and twenty-three before the Notary, Don Roque Encina, and which is noted in the Register of Property of the District of San Roque, folio nine hundred and ninety, et sequitur, of one thousand nine hundred and twenty-four. The related acts of title in greater detail, which I have before me and which I shall pass to the buyer, I certify, with notations and copy. The real property under consideration owes no territorial taxes for the current year, according to the poll ticket No. 12,897; has not suffered modification nor restrictions of dominion; and does not recognize any charge according to the certificate issued by the Register of Property, which I have on hand, and which I attach to this deed. Nor is there owing municipal taxes due for the services of lighting and cleaning, according to the respective titles, all of which I certify. In such conditions Mrs. (Seller) effects the sale of the parcels of land bounded and related with all buildings and appurtenances to Mr. (Buyer) for the sum of three hundred and ten thousand pesos (3.19 pesos to $1) of legal tender, and payable in the following manner: fifty thousand pesos of the said sum to be paid to the seller by the purchaser in this act, in my presence and that of the witness, for which receipt is given in writing, and the balance of two hundred seventy thousand pesos of legal tender the purchaser is obliged to pay in five annual installments, the first four of fifty thousand pesos of legal tender each, and the last of seventy thousand pesos of the same currency, the first installment falling due on the thirtieth of June, one thousand nine hundred and thirty-two, and the succeeding installments annually from that date, without interest and with the mortgage guarantee of the same--well rooted, and from then, in the tradition of the thing sold, the rights of property and possession are transferred to the purchaser, eviction, and improvement of the land according to law being obligatory. The purchaser being informed of the terms of this deed issued to his favor manifests his agreement and acceptance by adding that in guarantee of the full payment to the seller of the said balance of the price, or the sum of two hundred and seventy thousand pesos of legal tender, he leaves the same real property, which is acquired by this deed, mortgaged, including that constructed, attached or planted, in favor of Mrs. (Seller), who is empowered at once according to law. Mrs. (Seller), in turn, being informed of this deed of mortgage constituted in her favor, accepts it in all its parts and adds that being able to dispose freely of her assets, as is accredited by another certificate, which I also leave attached to this contract, by this deed cedes and transfers to the mortgager the hypothecary credit, which is constituted in his favor in this writing by the seller above the individualized property by the price of two hundred and seventy thousand pesos of legal tender, which

the conveyer receives of the conveyee in this deed, which I certify, and by which she gives him a letter of payment in due form. She immediately renounces the credit mentioned, and transfers them to the acquirer being bound by the eviction of law. The mortgager manifests that he is in agreement with and accepts this deed of transfer of hypothecary credit issued in his favor and imposed by him. The mortgager and purchaser also agree that the hypothecary obligation is cancelable at any time, which I certify. The duty of inscription is understood. Read and ratified, thus authorized and signed by the witnesses, Mr. Gabriel Valdovinos and Mr. Felipe Jara Casco, neighbors, of age, and to my knowledge, competent, who have also read this before me, I certify it. It goes to folio seven hundred and forty, et sequitur.
Seller's Husband. Buyer. Mortgager.
Witness: G. Valdovinos
" Felipe Jara Casco
Before me, Calixto F. Gonzalez. Sealed and stamped. This Testimony Faithfully Agrees with the original of its tenor, which passed before me in the Civil Register in my charge to the folio seven hundred and forty, et sequitur. I certify it. I issue this first copy, which I sign and seal in the place of its authorization on the sixth day of June, one thousand nine hundred and thirty-one to the purchaser."

From a letter dated Asunción, July 19, 1937, by Glenn A. Abbey, American Consul, to Robert A. Huston, Chicago Title & Trust Company, 69 West Washington Street, Chicago, Illinois.

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"The file of the attached copy has 14 official instruments from the time of its subdivision from a large property in 1901 to the last transfer in 1931.

"In Paraguay, when a piece of property is transferred from one person to another, the interested parties employ a notary. He is charged with bringing before the purchaser a certificate of mortgage. This he obtains from the Registro de Hipotecas (Mortgage Registry). He must also produce a certificate that all taxes have been paid. Then the original and certified copy of the documents pertaining to the property--from the original clear title on down--are displayed, and the notary makes an original and certified copy of the transfer. He retains the original, with all the original documents, and delivers certified copies, with all other certified copies, to the purchaser. The latter then sends his certified copy to the Registro de Propiedades, where it is certified and returned. No property can be transferred without all documents, back to the original, being produced.

"Many properties are imperfectly surveyed, particularly in the rural districts, therefore the parties resort to Mensura Judicial (Measurement by a Judge), who demands the presence of all persons holding adjacent properties. He then announces the properties limits, according to the seller, and if anyone contests the assertions of the seller, the judge investigates, and finally delimits the property."

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